COMMONWEALTH INST. ENTOM. LIBRARY
26 JAN 1950
SERIAL U.S.A. 146
SEPARATE

Mosquito News

Published Quarterly
by the
AMERICAN MOSQUITO CONTROL ASSOCIATION

VOLUME 9 DECEMBER, 1949 NUMBER 4

CONTENTS

ARTICLES PAGE

Precautions in the Use of Insecticides for Mosquito Control....F. C. Bishopp 137
The Relative Effectiveness of Several Insecticides Against Mosquito Larvae in Alaska. C. M. Gjullin, C. S. Wilson, B. V. Travis and George L. Hutton 142
The Effectiveness of DDT and Other Insecticides as Larvicides Against Arctic Species of *Aedes*. Wm. C. McDuffie, H. F. Cross, C. R. Twinn, A. W. A. Brown and C. N. Husman 145
A Comparison of DDT and Other New Insecticides for Mosquito Control. C. C. Deonier, E. S. Raun, A. N. Davis, Jr., and Edw. Nottingham 150
DDT Larvicides Dispersed by Spray and Thermal Aerosol Planes for the Control of *Aedes dorsalis* (Meigen) and *Aedes nigromaculis* (Ludlow). Harvey I. Magy, Arve H. Dahl, A. F. Geib, and Seth J. Kirkwood 153
Jeep Exhaust Venturi Aerosol....Robert W. Jones, III, and James R. Holten 161
Spray Equipment for C-47, UC-64, and L-5 Airplanes....C. N. Husman 166
The Occurrence of *Aedes* (*Ochlerotatus*) *thelcter* Dyar in the Florida Keys. Ernestine B. Thurman, Jas. S. Haeger and John A. Mulrennan 171
Notes on Mosquito Collections in Pennsylvania and Canada During 1948. Stanley J. Carpenter 172
Extension of Known Range of *Aedes atropalpus* (Coquillett) Southeastward into Georgia. B. D. Stough, M. A. King and D. E. Eyles 173
An Analysis of the Pupal Chaetotaxy of *Anopheles quadrimaculatus* (Say). G. H. Penn and S. A. Coleman 174
An Improved Insect Collecting Cage....P. C. Beaver and O. K. Fletcher, Jr. 176

NEWS AND NOTES.... 178

EDITORIAL.... 180

ASSOCIATION NEWS.... 180

REVIEWS AND ABSTRACTS

Malaria. The Biography of a Killer. By Leon J. Warshaw....Paul F. Russell 183
Report on the Third Session, Expert Committee on Malaria....F. C. Bishopp 183
Contributions to the Knowledge of the Danish and Fennoscandian Mosquitoes. By Lief B. Natvig....Kenneth L. Knight; C. R. Twinn 184
Un Caso de Eliminacion Local de *Anopheles darlingi* por Obras de Ingeniería Sanitaria. By A. L. Berti....Author's summary 185
Colonizacion en El Laboratorio, de *Anopheles aztecus* Hoffman. By W. G. Downs, E. Bordas, and A. Arizmendi....H.L.T. 185
An Epidemic of Malaria in the Kenya Highlands Transmitted by *Anopheles funestus*. By R. B. Heisch and J. O. Harper....Authors' summary 186
The Anopheline Mosquitoes of Taiwan (Formosa), China. By C. Y. Chow. E. B. Thurman 186

GENERAL BIBLIOGRAPHY.... 187

LIST OF ADVERTISERS.... 194

ADVERTISING RATES.... vi

MOSQUITO NEWS

Official Publication of the American Mosquito Control Association

PUBLICATIONS COMMITTEE

R. D. Glasgow, Chairman, Albany, N. Y.
C. T. Williamson, Yaphank, N. Y.
T. D. Mulhern, Fresno, Calif.
H. D. Peters, Jacksonville, Fla.
Archie D. Hess, Savannah, Ga.
Bernard V. Travis, Ithaca, N. Y.

Editorial Office, State Education Building, Albany, N. Y.

R. D. Glasgow, Consulting Editor — D. L. Collins, Acting Editor
Margaret G. Slater, Editorial Assistant

Associate Editors

H. H. Stage (Current Bibliography—"References to Literature of Interest to Mosquito Control Workers"), Washington, D. C.
Helen Louise Trembley (Reviews and Abstracts), National Institutes of Health, Bethesda 14, Md.
Richard F. Peters, Berkeley 1, Calif.

R. L. Vannote, Advertising Manager, Morristown, N. J.
C. T. Williamson, Business Manager, Yaphank, N. Y.
T. D. Mulhern, Secretary and Treasurer of the Association, Fresno, Calif.

Published by
AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by
Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public service.

SUBSCRIPTION RATES

$4.00 per Year (U. S. money), Single Copies, $1.00
Mailed without charge to members of the Association.

MEMBERSHIP DUES

Associate Members $4.00
Active Members 5.00

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in Mosquito News should be addressed to Donald L. Collins, Acting Editor, Mosquito News, New York State Musuem, Albany, New York.

Communications relating to advertising space should be addressed to R. L. Vannote, Advertising Manager, Mosquito News, 3 Franklin Place, Morristown, New Jersey.

Communications relating to subscriptions to Mosquito News, Membership in the American Mosquito Control Association, and other association matters should be addressed to Thomas D. Mulhern, Secretary-Treasurer, American Mosquito Control Association, 335 Rowell Building, Fresno, California.

Copyright 1949 by
The American Mosquito Control Association

ARTICLES

PRECAUTIONS IN THE USE OF INSECTICIDES FOR MOSQUITO CONTROL

F. C. BISHOPP

Assistant Chief, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture

Insecticides have come to play a dominant part in mosquito control. To a large degree the more expensive yet more permanent work of eliminating breeding places has given way to spraying for the elimination of larvae and adult mosquitoes.

The great success that has attended the use of DDT as a residual spray in buildings and as a spray or fog to kill adults and larvae out of doors has caused many agencies to adopt this insecticide as practically the sole means of fighting malaria and other mosquitoes.

It has long been recognized by entomologists that some hazards attend the use of any insecticide and that certain materials must be handled with extreme care. DDT is the most effective and widely used mosquito-killing material. The facts that it is relatively low in acute toxicity to higher animals (from the acute standpoint) and that it has received such popular acclaim have caused some users to overlook certain important safety considerations. On the other hand, some of the extreme and often unfounded statements regarding the dire consequences that are resulting from its use have caused certain elements of the public to be excessively critical.

An important factor that enters into the hazards associated with the use of insecticides is that DDT-resistant flies, mosquitoes, and other pests are developing, which may lead to the use of increased dosages and more frequent applications. It should be remembered also that DDT and other chlorinated hydrocarbon insecticides are being extensively employed in combating forest and field-crop insects and pests of livestock against which insecticides were previously used little if at all.

The public reaction against the use of DDT has led some mosquito-control workers to turn to some extent to other insecticides, and the resistance factor is making it necessary to give consideration to alternative materials.

It is obviously necessary, therefore, for mosquito fighters to have knowledge not only of the mosquito-killing powers of the several insecticides that may be used, but also of the possible hazards to the operator and to the public from their improper use.

Many factors must be considered in appraising the potential health hazards of an insecticide in connection with its preparation and use for controlling mosquitoes. These include their effect on the workers in manufacturing, processing, and packing plants; on field workers who may mix and apply the materials, on people through contamination of utensils, foods and even the air in buildings; on people who consume contaminated crops, either directly or indirectly; and on birds, fish, reptiles, amphibians, bees, parasites, and predaceous insects and other beneficial forms of life.

Some indication of the relative acute and chronic toxicity of a number of the insecticides now being used is given in the Tables 1 to 3, which were prepared by A. J. Lehman (1948), of the Food and Drug Administration.

It is obvious from these tables that DDT does not possess sufficient acute toxicity to cause concern when used with reasonable

TABLE 1.—Comparison of the acute oral toxicities of insecticides with DDT to several species of laboratory animals.

Insecticide	Mean lethal dose mg./kg.	Ratio
DDT (dichloro-diphenyl-trichloroethane)	250	1
TEP (tetraethyl pyrophosphate)	2	125
Parathion (O, O-diethyl O-p-nitrophenyl thiophosphate)	3.5	70
HETP (hexaethyl tetraphosphate)	7	35
Nicotine	10	25
Chlorinated Camphene (68% chlorine)	60	4
Rotenone	60 (to 3,000)	4
GBH (gamma isomer of benzene hexachloride)	125	2
Lethane-384 Special (a mixture of three parts Lethane-60 (beta-thio-cyano-ethyl esters of aliphatic acids with 10–18 carbon atoms) and one part of Lethane-384 (beta-butoxy-beta-thio-cyano-diethyl ether) plus refined paraffin)	400	5/8
Lethane-60 (beta-thio-cyano-ethyl esters of aliphatic acids with 10–18 carbon atoms)	500	1/2
ABH (alpha isomer of benzene hexachloride)	500	1/2
Chlordane (1, 2, 4, 5, 6, 7, 8, 8-octachloro-4, 7 methano-3a, 4, 7, 7a-tetrahydroindan)	500	1/2
Thanite (isobornylthiocyanoacetate)	1,000	1/4
DBH (delta isomer of benzene hexachloride)	1,000	1/4
Pyrethrins	1,500	1/6
TDE (dichloro-diphenyl-dichloroethane)	2,500	1/10
BBH (beta isomer of benzene hexachloride)	>6,000	>1/24
Methoxychlor (dimethoxy-diphenyl-trichlorethane)	>6,000	>1/24
N-propyl isome (di-n-propyl-6, 7-methylene-dioxy-3-methyl-1, 2, 3, 4-tetrahydronaphthalene-1, 2-dicarboxylate)	>10,000	1/40
Piperonyl butoxide (butylcarbityl) (6-propyl piperonyl) ether)	12,800	1/50

TABLE 2.—Chronic Toxicity in Rats

Insecticide	Lowest level producing gross effects p.p.m. *	Duration weeks	Remarks
DDT	100	104	
Parathion	25	4	
HETP		12	1000 p.p.m.; no effect
Nicotine	60	43	
Chlorinated camphene	–	8	1200 p.p.m.; no effect
Rotenone	31.2	16	
GBH	400	52	
Lethane-384 special			No data
Lethane-60			No data
ABH	800	43	
Chlordane	250	12	
Thanite			600 mg./kg./day fatal in 4–12 weeks
DBH	3,200	52	
Pyrethrins			500 mg./kg./day fatal in 2 weeks
TDE	2,500	104	
BBH	10	36	
Methoxychlor	5,000	16	
N-propyl isome			No data
Piperonyl butoxide			No data

* p.p.m., parts per million.

TABLE 3.—Chronic Toxicity in Dogs

Insecticide	Dietary levels p.p.m.	Remarks
DDT	2,640	Death in 50 days
Chlorinated Camphene	330	Death in 33 days
Rotenone		2 gm./kg. single doses; survival
GBH	330	Death in 30 weeks
ABH	2,000	Death in 44 days
Chlordane	660	Death in 4 weeks
DBH	3,960	Death in 14 weeks
Pyrethrins	Large amounts	Survival
TDE	1,650	Survival for 19 months
BBH	1,320	Death in 90 days
Methoxychlor	10,000	Survival for 6 months

precautions, nor is it irritating to the skin. However, the fact that it is stored in the fatty tissues and is excreted in the milk of animals exposed to DDT, either directly or by consuming feed that bears a residue, is an important consideration. Furthermore, the Food and Drug Administration has reported that the daily intake by rats of 5 p.p.m. of DDT will develop liver damage that is minimal but characteristic.

PRECAUTIONS SUGGESTED

It is difficult to lay down hard-and-fast rules for the safe handling, storage, and use of all insecticides that may be used in mosquito control. The same set of precautions are not applicable to all materials or all conditions. However, all insecticides should be stored out of the reach of children and where they will not be accidentally used as baking powder or other food materials. When mixing and applying insecticides it is a good plan to consider all of them as poisonous.

Solvents—A number of different solvents are being used in the preparation of insecticide solutions and emulsions. Xylene, the alkylated naphthalenes, fuel oil, and kerosene are most commonly employed. Each of these solvents has some toxicity, and some of the reported ill effects of DDT are clearly chargeable to the solvents.

Xylene and some other volatile solvents are inflammable, and breathing the fumes may cause headache and nausea. Some of these materials cause the skin to become dry and crack. Some of the alkylated naphthalenes may irritate the skin and even cause severe dermatitis, especially when the sensitized skin is exposed to the sun.

DDT—Emulsions and solutions of DDT in concentrated form which come in contact with the hands or body should be removed immediately with soap and water. Dilute solutions, emulsions, and wettable-powder preparations should not be left long in continuous contact with the skin. DDT emulsions often contain xylene as the solvent. When mixing emulsions rubber gloves should be worn to protect the hands, and prolonged breathing of the vapors should be avoided. Indoor spraying with xylene sprays should be done in well-ventilated rooms. During the spraying the eyes should be protected with goggles, and it is advisable to wear a respirator and make frequent changes of filter pads.

Tables and shelves where food is placed, as well as baby beds and children's toys, should be completely covered or removed from the room while it is being sprayed. Foods and utensils should be well protected from the spray.

DDT should not be applied to cats or dairy animals, and DDT-oil solutions should not be applied heavily to any animal.

In general aerial applications of DDT sprays over towns, vegetable gardens, and pastures should be avoided if other means of mosquito control are feasible. Single or infrequent light applications, less than one-third of a pound of DDT per acre, applied to populous areas from the air to wipe out swarms of mosquitoes probably present no health hazard to humans but fish in ornamental pools might be affected.

Since DDT consumed by dairy cows will readily appear in their milk, no DDT sprays should be applied to pastures where dairy animals are grazing or to crops that are to be harvested for feeding to these animals.

Insecticidal mists or fogs when properly applied are less likely to leave appreciable residues on gardens and meadows than are sprays. Questions have been raised as to the hazard of breathing such fogs. There is no indication that breathing such fogs or mists for a short time will produce ill effects. The use of fogs in some situations has been reported to create traffic hazards because of effect on visibility.

Aerial applications of DDT at rates up to one pound per acre have been found to cause no serious injury to fish and other forms of wildlife (Linduska and Surber 1948). However, spraying of open water, such as wide rivers and lakes, should be avoided, since the insecticide may be drifted to the margins by the wind and thus concentrated sufficiently to kill fish.

Remnants of spray from tanks and the washings from spray equipment should be drained into a hole in the earth or in places where they will not gain access to streams and ponds. Insecticides should never be mixed on or near wells.

Toxaphene, TDE, Methoxychlor, Benzene Hexachloride, Lindane, and Chlordane—The same general precautions should be followed in handling each of these chlorinated hydrocarbon insecticides. Although they are not now widely used in combating mosquitoes, it is possible that these and other new related materials may come into more extensive use. Methoxychlor and TDE are less toxic than DDT to warm-blooded animals from both acute and chronic standpoints. However, toxaphene, chlordane, and lindane have much greater toxicity than DDT when absorbed through the skin. Moreover, toxaphene is particularly poisonous to fish. TDE, on the other hand, appears to be considerably less toxic to fish than DDT or any of the other chlorinated hydrocarbon insecticides in the above heading. Benzene hexachloride, lindane, and chlordane have a fumigating effect, and it is conceivable that in confined spaces the fumes may produce ill effects.

Parathion and Other Phosphorus Compounds—Parathion is highly effective in destroying mosquitoes, but, as is shown in the tables, *it is an extremely poisonous compound. Already three deaths of operators have been reported from its use for the control of crop pests.* Parathion residues do not persist long. Parathion has not been recommended for mosquito control, but in the event some may use it under special circumstances, operators should be provided with gas masks fitted with appropriate cartridges to neutralize organic poisons of that type. Protective clothing and gloves should be worn, so that the spray will not come in contact with any part of the body. Special care should be taken in handling concentrates (15% or more), particularly in emptying this material into spray tanks. The operator should have available soap and water and a change of clothing. If through some accident the parathion insecticide should come in contact with the clothing or skin, the clothing should be removed immediately and the contaminated parts of the body washed. Atropine should be available in the event of actual poisoning (see "Antidotes").

Hexaethyl tetraphosphate and tetraethyl pyrophosphate are extremely poisonous, but it is unlikely that these materials will be used in mosquito control because of their lack of residual effect.

2, 4-D and Other Weed Killers—Al-

though weed killers are not insecticides, they are of value in mosquito control under some conditions. The toxicity of these materials to animal life is very low (Mitchell, Hodgson, and Gaetjens 1946). However, their potency in destroying broadleaf plants is not confined to weeds along pool margins and ditch banks. Their application from the air is prohibited by law in some states, because of the danger of the spray drifting onto susceptible crops. Every precaution should be taken to prevent drift, as extremely small quantities carried by the wind may cause serious damage.

Spray equipment used to apply weed killers preferably should not be used to apply insecticides, especially near crops. If it is so used, it should be thoroughly cleaned. It is recommended that the spray tank be filled with lye water (13 oz. of lye per 100 gal.), and after it has stood for several hours the material is pumped out through the lines.

ANTIDOTES

In the case of suspected poisoning from any insecticide, a physician should be called immediately. However, in view of the newness of this group of insecticides, physicians may not be aware of the antidotes recommended. Hence the following information is presented:

There is no specific antidote for accidental poisoning by DDT and other chlorinated hydrocarbon insecticides, although phenobarbital has been found to allay the tremors resulting from such poisoning. The usual procedure of emptying the stomach with emetics, or better, stomach pump, is indicated in cases where these insecticides are swallowed.

Atropine is the antidote usually advised for parathion poisoning. Morphine should never be given.

SOME RULES TO OBSERVE

1. Be sure an insecticide is needed.
2. Choose the most effective and safest insecticide.
3. Apply the insecticide properly, which means use suitable equipment properly adjusted.
4. Apply the material under favorable weather conditions.
5. Use the best formulation for the purpose.
6. Apply the minimum quantity consistent with effective control.
7. Time the applications in relation to mosquito development in order to accomplish the greatest good.
8. Make no more applications than necessary.
9. Follow all practices to safeguard the operator and the health and interests of the public.
10. Be familiar with antidotes and have them and other precautionary devices at hand when working with highly toxic materials such as parathion.

REFERENCES TO TOXICOLOGICAL PUBLICATIONS ON INSECTICIDES

CALVERY, H. O., AND NEAL, P. A. 1946. The toxicity of DDT, solvents, emulsifiers, activators, and other adjuvants mentioned in this report. *U. S. Dept. Agr. Misc. Pub.* 606:69–71.

DECKER, G. C. 1946. The agricultural applications of DDT, with special reference to the importance of residues. Minutes of Conference on Toxicity of DDT, Biological Subcomm., Natl. Research Council.

DIVISION OF INSECTS AFFECTING MAN AND ANIMALS. 1949. The new insecticides for controlling external parasites of livestock. *U. S. Bur. Ent. and Plant Quar.* E-762, Rev. 25 pp. [Processed.]

LEHMAN, A. J. 1948. The toxicology of the newer agricultural chemicals. *Assoc. Food and Drug Off. Bul.* 12(3):82–89.

————. 1949. The major toxic actions of insecticides. *N. Y. Acad. Med. Bul.* 25(6):382–387.

LINDUSKA, J. P., AND SURBER, E. W. 1948. Effects of DDT and other insecticides on fish and wildlife. Summary of investigations during 1947. *U. S. Fish and Wildlife Serv.* Cir. 15, 19 pp.

MITCHELL, J. W., HODGSON, R. E., AND GAETJENS, C. A. 1946. Tolerance of farm animals to feed containing 2, 4-dichlorophenoxy acetic acid. *Jour. Animal Sci.* 5(2):226–232.

NEAL, P. A. 1945. DDT toxicity. A report on the toxicity to warm-blooded animals of

aerosols, mists, and dusting powders containing DDT. *Soap and Sanit. Chem.* 21(1):99–101, 111.

——— AND OTHERS. 1944. Toxicity and potential dangers of aerosols, mists and dusting powders containing DDT. *U. S. Pub. Health Serv. Rpt.* Suppl. 177, 31 pp.

———, VON OETTINGEN, W. F., DUNN, R. C., AND SHARPLESS, N. E. 1945. Toxicity and potential dangers of aerosols and residues from such aerosols containing three percent DDT. Second Report. *U. S. Pub. Health Rpt.* Sup. 183, 32 pp.

PARKER, J. R. 1949. Toxaphene residues. *Mont. Agr. Expt. Sta. Tech. Bul.* 461, 26 pp.

PHILIPS, F. S., AND GILMAN, A. 1946. Studies on the pharmacology of DDT (2, 2-bis-(p-chlorophenyl)-1, 1, 1-trichloroethane). I. The acute toxicity of DDT following intravenous injection in mammals with observations on the treatment of acute DDT poisoning. *Jour. Pharmacol.* 86(3):213–221.

POST, R. L., AND MUNRO, J. A. 1949. Mosquitoes of North Dakota. *N. Dak. Agr. Expt. Sta. Bimo. Bul.* 11(5):173–183.

UNITED STATES BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE AND PUBLIC HEALTH SERVICE. 1947. DDT for control of household pests. *U. S. Dept. Agr. and Fed. Sec. Agency.* Unnumbered Pub., 15 pp.

WEBSTER, R. L. 1948. New Insecticides: Their uses, limitations and hazard to human health. *Wash. Agr. Expt. Sta.* Cir. 64.

WELCH, N. 1948. Tests of the toxicity to sheep and cattle to certain of the newer insecticides. *Jour. Econ. Ent.* 41:36–39.

WILSON, S. G. 1948. Feeding of Gammexane and DDT to bovines. *Bul. Ent. Res.* 39: 423–434.

THE RELATIVE EFFECTIVENESS OF SEVERAL INSECTICIDES AGAINST MOSQUITO LARVAE IN ALASKA [1]

C. M. GJULLIN,[2] C. S. WILSON,[3] B. V. TRAVIS,[2] AND GEORGE L. HUTTON [3]

Tests to determine the effectiveness of a number of insecticides against *Aedes* mosquito larvae were made on 146 one-eighth- to one-half-acre plots in the Anchorage, Eklutna, and Gulkana, Alaska, areas in May and June of 1947 and 1948. Several of the insecticides were also tested against *Culiseta* larvae.

The test areas in 1947 ranged from clear, open pools to pools almost completely filled with sedges. In some pools the water was covered with a heavy scum. The most common species of larvae were *Aedes punctor* (Kby.), *A. pionips* Dyar, and *A. communis* (Deg.). Nearly all the larvae were in the fourth instar, and many were pupating when the tests were made.

Fuel-oil solutions of DDT, benzene hexachloride, chlordane, and toxaphene (chlorinated camphene), and water emulsions of DDT were applied with a small hydraulic-type hand sprayer that produced a fine mist spray. The DDT and benzene hexachloride wettable powders were applied with a small hand sprayer, and the DDT dusts were dispersed with a small plunger duster.

The results of the tests against *Aedes* larvae (Table 1), indicated that oil solutions and water emulsions of DDT were about equally effective and somewhat better than benzene hexachloride in oil solution. These two chemicals appeared superior to the other chemicals and formulations tested. The tests against *Culiseta* larvae (Table 2), further showed DDT and benzene hexachloride to be superior to chlordane and toxaphene.

A suitable sprayer for dispersing wettable DDT powder was not available, and

[1] This work was conducted under funds allotted by the National Military Establishment to the Bureau of Entomology and Plant Quarantine.

[2] U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine.

[3] Entomologist, U. S. Army Engineers.

TABLE 1.—Effectiveness against *Aedes* larvae of various insecticides applied as sprays and dusts. Small-plot tests near Anchorage and Gulkana, Alaska. May and June 1947.

Material	Dosage (Pound/acre)	Number of tests	Percent mortality in 24 hours	Percent mortality in 48 hours
DDT				
5% in fuel oil	0.2	6	91	98
	.1	10	87	93
	.05	8	66	68
5% emulsion	.2	4	97	93
	.1	7	84	97
	.05	5	93	90
2.5% suspension made from 50% wettable powder	.2	6	64	77
	.1	5	93	79
	.05	4	85	83
10% dust	.2	2	81	57
	.1	3	39	57
Benzene hexachloride (12% gamma), 2.5% in fuel oil	.2	3	86	83
	.1	5	91	84
	.05	2	88	81
Benzene hexachloride 2.5% suspension made from 50% wettable powder containing 6% of gamma isomer	.2	7	64	76
	.1	6	92	82
	.05	6	47	59
Chlordane, 5% in fuel oil	.2	5	60	62
	.1	9	51	55
Toxaphene, 5% in fuel oil	.2	5	56	74
	.1	5	89	80
	.05	3	25	59

TABLE 2.—Effectiveness against *Culiseta* larvae of various insecticides applied as 5-percent sprays. Small-plot tests near Anchorage, Alaska, July 1947.

Material	Dosage (Pound/acre)	Number of tests	Percent mortality in 24 hours	Percent mortality in 48 hours
DDT				
In fuel oil	0.2	2	95	94
	.1	2	94	88
	.05	2	94	91
In water emulsion	.2	2	88	89
	.1	2	77	90
	.05	1	52	79
Chlordane in fuel oil	.2	2	46	70
	.1	1	0	61
Toxaphene in fuel oil	.2	2	45	59
	.1	1	9	12
	.05	1	51	11
Benzene hexachloride, 5% in fuel oil from 83% gamma powder	.05	1	48	82

the results of the individual tests varied considerably. The mortalities may have been unduly low because of faulty application. Both low and high kills were recorded from plots with a heavy surface scum or with heavy grass or reed cover, but mortality was invariably high in clear, open pools. Poor results (not included in Table 1) were also secured on five plots in a low marsh bordering the dock area at Anchorage. Large numbers of *Aedes punctor* and *A. communis* larvae were present in the water between shrub-covered tussocks on this flat seepage area, but no significant mortality was observed after the application of DDT in fuel oil, even at dosages of 0.3 and 0.4 pound per acre.

In 1948 tests with DDT, TDE, methoxychlor, and parathion oil solutions were made on 30 one-half-acre plots near Anchorage and Eklutna. The most common species of larvae were *Aedes punctor, A. communis,* and *A. pionips.* The larvae ranged from first to fourth instars, and third or fourth instars predominated in all tests. The sprays were applied with a small hydraulic-type sprayer and with a hand pump atomizer.

The tests in the Anchorage area were made on mossy pools partially filled with grass. The results of the tests on these plots (Table 3), indicated that TDE and methoxychlor were about equal to DDT at 0.1 pound per acre. A freshly prepared oil solution of parathion at 0.025 pound per acre was indicated to be nearly four times as toxic as DDT. A parathion-fuel-oil solution, about 2 months old, showed no toxicity to mosquito larvae at 0.02 pound per acre.

In the Eklutna plots the larvae occurred in pools between shrub-covered tussocks on flat seepage areas. In these tests TDE, DDT, and methoxychlor were much less effective at 0.1 pound per acre than in the Anchorage area. These plots were similar with respect to drainage and vegetation to those in which 0.4 pound of DDT failed to give larval kills in 1947. Prehatching sprays applied to this type of breeding area have also been found less effective than on other types of areas (Travis *et al.* 1949). The reasons for the ineffectiveness of the insecticides under these conditions were not determined.

SUMMARY

Tests of DDT, TDE, methoxychlor, benzene hexachloride, chlordane, toxaphene, and parathion were made against *Aedes* mosquito larvae on 146 one-eighth- to one-half-acre plots near Anchorage, Eklutna, and Gulkana, Alaska. Nineteen tests were also made against *Culiseta*

TABLE 3.—Effectiveness against *Aedes* larvae of different insecticides in fuel oil. Small-plot tests near Anchorage and Eklutna, Alaska. May 1948.

Material and concentration	Dosage (Pound/acre)	Number of tests	Percent mortality in 24 hours	Percent mortality in 48 hours
	Anchorage			
TDE, 2.5%	0.1	3	84	84
Methoxychlor, 2.5%	.1	3	79	82
Parathion, 0.25%	.025	3	59	66
DDT, 20%	.1	2	66	88
	.2	5	93	97
Velsicol AR-50[1] 50%	2 quarts	2	0	0
	Eklutna			
TDE, 2.5%	0.1	4	55	68
DDT, 2.5%	.1	4	44	52
Methoxychlor, 2.5%	.1	4	44	48

[1] Chiefly mono- and dimethyl-naphthalenes.

larvae. DDT oil solutions and water emulsions were about equally effective against *Aedes* larvae and superior to DDT and benzene hexachloride wettable powders and to DDT larviciding powder. These DDT formulations were also more effective than fuel-oil solutions of benzene hexachloride, chlordane, and toxaphene. DDT, TDE, and methoxychlor fuel-oil solutions were about equal in effectiveness. Against *Culiseta* larvae, DDT in fuel oil and in water emulsion was superior to fuel-oil solutions of chlordane, benzene hexachloride, and toxaphene. In the Anchorage area dosages of 0.1 to 0.2 pound of DDT per acre caused 88 to 97 percent kill of *Aedes*. A dosage of 0.1 pound per acre of DDT proved inadequate for control under conditions prevailing in the Eklutna area.

Literature Cited

Travis, B. V., C. M. Gjullin, F. S. Blanton, N. Smith, and C. S. Wilson. 1949. Prehatching treatments for the control of *Aedes* in Alaska. *Mosquito News* Vol. 9, No. 2, 42–48.

THE EFFECTIVENESS OF DDT AND OTHER INSECTICIDES AS LARVICIDES AGAINST ARCTIC SPECIES OF *AEDES* [1]

WILLIAM C. McDUFFIE,[2] H. F. CROSS,[2] C. R. TWINN,[3] A. W. A. BROWN,[4] AND C. N. HUSMAN [2, 5]

In 1947 and 1948 an experimental program was carried out at Ft. Churchill, Manitoba, Canada, by Canadian and United States entomologists to determine the applicability of present-day methods of mosquito control against arctic and subarctic species of *Aedes* mosquitoes. The program included studies on the effectiveness of prehatching treatments (McDuffie *et al.* 1949), adulticides (Goldsmith *et al.* 1949), and larvicides applied with ground and aerial equipment. The greatest effort was devoted to the study of larvicides, over 150 tests being made with DDT and 7 of the newer insecticides that had shown promise as larvicides in screening and field tests at Orlando, Fla. (Deonier *et al.* 1949). Although most of the tests were made on small plots to evaluate the various insecticides, sufficient tests were also made on large areas with aerial and ground equipment to determine the effectiveness of DDT on a practical scale. The results of the larvicidal investigations for the 2 years are given in this paper.

Test Conditions and Methods

Larvicidal treatments were applied during June on pools and grassy depressions in the tundra and along the margins of lightly forested areas. Several species were present in most of the plots, with *Aedes nigripes* (Zett.) and *A. punctor* (Kby.) predominating. Other species present and

[1] The results herein reported were obtained through the joint efforts of the Canadian Division of Entomology, on behalf of the Canadian Defense Research Board, and the U. S. Bureau of Entomology and Plant Quarantine, on behalf of the Army Committee for Insect and Rodent Control.

[2] U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine.

[3] Canadian Dept. Agr., Division of Entomology, Science Service.

[4] Canadian Defense Research Board.

[5] Acknowledgment is made of the valuable contributions of the following members of the joint U. S.-Canadian group: J. B. Goldsmith, Major, Sn.C., U. S. Army; B. Hocking, Douglas Peterson, John Rooks and R. W. Fisher, Canada.

identified in the larval form included *A. communis* (Deg.), *A. campestris* D. and K., and *A. excrucians* (Walk.). Tests were made when the majority of the larvae were in the fourth instar.

In 1947, 60 plots, 1,000 to 10,000 square feet each, were treated with 4 insecticides applied in the form of emulsions and fuel-oil solutions. Fuel-oil solutions at the rate of 1 or 2.5 gallons per acre and emulsions at 5 gallons per acre were applied with hand-pressure sprayers. The percentage of toxicant was varied to give the desired dosages. Swath intervals were 5 feet for the water-emulsion treatments and up to 15 feet for the smaller quantities of oil solution. In 1948, 95 tests were made on small plots with DDT and 4 other insecticides as oil solutions or as wettable powders. The desired dosages were applied in 1 gallon of oil or water per acre. Swath intervals of about 20 feet were maintained in applying treatments.

A large aircraft (R.C.A.F. C-47), equipped with cargo tanks and a vertical, gravity-flow discharge pipe (3 3/8 inches in diameter) extending 14 inches below the fuselage, was used to treat four plots 0.5 to 2.5 square miles in area, in open tundra and forested areas. A 5-percent DDT-fuel-oil solution was sprayed on two plots at swath intervals of 100 yards and on two at intervals of 200 yards to give dosages of about 2 and 4 imperial quarts of solution per acre. The height of flight in the first test varied from 125 to 185 feet, but thereafter it was maintained as nearly as possible at 100 feet. Dipping stations were established at 10 or more points throughout each test area.

Two tests were conducted on open tundra breeding areas of approximately 60 acres each, an old-type Hochberg-LaMer aerosol generator (LaMer and Hochberg 1945) being used for dispersing the DDT emulsion. In each test the generator was drawn back and forth along a front line of about 500 yards until the quantity of liquid necessary to give 0.1 and 0.3 pound of DDT per acre was dispensed. Larval dipping stations were established at regular intervals throughout for a distance of 600 yards downwind from the emission line. Dipping checks were made in these and all other larvicide tests before and at 24- and 48-hour intervals after treatment to determine the control obtained.

RESULTS

Tests with Hand Equipment.—The results of the larvicide tests with hand equipment, both in 1947 and 1948, are shown in Table 1. In 1947, DDT was the most effective of the four materials tested. Applications of 0.04 and 0.1 pound per acre gave good to complete control of mature larvae of the several species involved. The emulsions appeared to be slightly better than the oil solutions. Emulsions of chlordane and toxaphene were effective at dosages of 0.1 and 0.2 pound per acre, and gave better results than an emulsion of benzene hexachloride. With oil solutions, the order of toxicity of these three materials was inconsistent at different dosages, but none of them caused a high mortality at dosages of 0.2 pound per acre or less. Chlordane in oil caused 100 percent mortality at 0.4 pound per acre, (not given in table) and benzene hexachloride (20 percent of gamma isomer) as an emulsion was effective at 0.5 pound per acre. None of the treatments was effective against pupae.

In the 1948 tests parathion proved to be the most toxic of the five materials tested, although only slightly more so than DDT. Both of these materials as wettable powders gave nearly complete kills of mature larvae at a dosage of only 0.05 pound per acre. Parathion was also highly effective at only 0.01 pound per acre, but at 0.005 pound per acre gave only 52-percent control, or about the same as DDT at a dosage of 0.01 pound per acre. In tests with oil solutions DDT, with one exception, yielded greater control of larvae at each test dosage than the other materials, 0.1 and 0.2 pound per acre causing 90 to 100 percent mortality in 48 hours. Meth-

TABLE 1.—Percent mortality of mosquito larvae obtained with various toxicants applied with hand-pressure sprayers, Churchill, Canada. June 1947 and 1948. (Average of 2 to 5 replications at each dosage.)

Toxicant	Dosages applied (pound per acre)							
	0.005	0.01	0.02	0.04	0.05	0.1	0.2	0.5
1947 Tests								
Fuel-oil solutions								
DDT	...	...	...	83	...	100	100	...
Chlordane	...	...	...	80	...	66	66	...
Toxaphene	...	...	...	52	...	71	...	...
Benzene hexachloride (20% gamma isomer)	...	...	...	0	...	83	...	...
Emulsions								
DDT	...	...	73	96	...	100	...	...
Chlordane	...	...	...	49	...	98	100	...
Toxaphene	...	...	...	0	...	100	85	...
Benzene hexachloride (20% gamma isomer)	...	...	...	...	...	69	18	100
1948 Tests								
Fuel-oil solutions								
DDT	...	49	...	...	69	90	100	...
TDE	...	2	...	...	62	82	57	...
Heptachlor	...	0	...	...	68	56	73	...
Methoxychlor	...	0	...	...	44	97	92	...
Wettable powders								
DDT	...	57	...	...	99	100	...	...
Parathion	52	90	...	...	98	100	...	...

oxychlor was about as effective as DDT at these dosages, but was inferior at lower dosages. TDE and heptachlor appeared to be as effective as DDT at the 0.05 dosage, but were inferior both to DDT and methoxychlor at dosages of 0.1 and 0.2 pound per acre.

Fuel oil alone applied at rates of 1 and 2.5 gallons per acre was relatively ineffective as a mosquito larvicide. In occasional tests slight to moderate kills resulted from each of these dosages, but in most tests no control was indicated.

The results obtained from the tests with DDT in 1948 confirm those of 1947. The data for the 2 years also indicate that this insecticide is equally as effective against arctic species of mosquito larvae as against those of the temperate and tropical species, and that the dosage necessary for control is closely comparable.

Tests with Aerial Sprays.—The results of four airplane tests are presented in Table 2. Complete control of mature larvae was obtained with fuel-oil solutions of DDT dispersed at the rate of 0.44 and 0.48 pound of DDT per acre. These treatments also gave 100 and 72 percent control, respectively, of pupae. In two other tests dosages of 0.26 pound of DDT per acre yielded 91 and 97 percent control of larvae but were relatively ineffective against pupae.

The camp area was of special interest because the treatment was effective in spite of wind velocities of 10 to 28 m.p.h. The large droplet size produced by the equipment used (mass median diameter of about 330 microns) was probably of advantage under these conditions. With so coarse a spray, however, swath widths of 600 feet, as used in two tests, were

TABLE 2.—Results of four aerial spray tests with DDT against larvae and pupae of mosquitoes. June 27 to July 5, 1947.

Test plot No.	Type of vegetation in area	Size of plot (acres)	Average Temperature (°F.)	Wind speed (m.p.h.)	Height of flight (feet)	Swath interval (feet)	Dosages per acre		Per cent control in 48 hours	
							DDT (pound)	Oil [1] (gallon)	Larvae	Pupae
1	Dwarf birch and willow; scattered spruce-larch	310	54	2.5–5	123–202	600	0.26	0.51	91	0
2	Spruce-larch forests 85%, bush 15%	728	60	4–8	50–180	300	.48	.96	100	72
3	Mixed spruce-larch forest and bush	654	52	8–10	45–90	600	.26	.51	97	40
4	Camp area; sparsely wooded ridge and tundra	1,781	64	10–28	50–180	300	.44	.89	100	100

[1] Dosages calculated on a basis of imperial gallons containing 5% of DDT.

evidently too great to permit uniform coverage.

Tests with Hochberg-LaMer Aerosol Generator.—Of the two tests conducted with a Hochberg-LaMer aerosol generator, only one yielded positive results. The data for this test are condensed in Table 3. Control of larvae was excellent for 100 yards downwind from the line of insecticide emission but declined as the distance from the emission line increased. At 500 to 600 yards only 50 percent control was indicated in 24 hours and 63 percent in 48 hours. The mean mortality over the surveyed area after 48 hours was 82 percent. In the other test, which involved a dosage of approximately 0.10 pound of DDT per acre, control was negligible, even within 100 yards of the emission line. The difficulty in towing the machine over the marshy terrain and the vagaries of the wind in the Churchill area render this method of dispersal of doubtful value for practical use in such areas.

SUMMARY

Studies were conducted at Ft. Churchill, Manitoba, Canada, in 1947 and 1948 by United States and Canadian entomologists to compare the effectiveness of DDT and seven new insecticides against arctic species of mosquito larvae, and to determine

TABLE 3.—Percent control of mosquito larvae with DDT applied at a rate of 0.30 pound per acre by means of a Hochberg-LaMer aerosol generator. June 1947.

Distance downwind from emission line (yards)	Number of stations	Control in	
		24 hours	48 hours
0–100	3	96	96
100–200	6	62	80
200–300	10	81	88
300–400	3	43	86
400–500	3	66	73
500–600	4	50	63
Mean mortality		63	82

whether the present methods of applying larvicides are feasible and effective under arctic conditions.

In comparative tests on small plots with hand sprayers, DDT and parathion as wettable powders gave nearly complete kills of mature larvae at a dosage of 0.05 pound per acre. Parathion was also highly effective at 0.01 pound per acre, but at this dosage DDT gave only 57 per cent control. Emulsions and wettable powders of DDT at 0.1 pound per acre were equally effective, and both gave somewhat higher kills than oil solutions. In comparative tests with oil solutions DDT, with one exception, yielded slightly to considerably greater kills of larvae at each test dosage than the other six materials tested, 0.1 to 0.2 pound per acre providing 90 to 100 per cent kills in 48 hours. Methoxychlor in oil solution was nearly as effective as DDT at these dosages but was inferior at lower dosages. TDE and heptachlor were about as effective as DDT at a dosage of 0.05 pound per acre but were inferior at both higher and lower dosages. Chlordane and toxaphene were less toxic in oil solutions than DDT, but gave comparable kills as emulsions at a dosage of 0.1 pound per acre. Benzene hexachloride (20 per cent gamma isomer) gave erratic and generally poor results, except as an emulsion at a dosage of 0.5 pound per acre. Fuel oil alone applied at rates of 1 and 2.5 gallons per acre was relatively ineffective as a mosquito larvicide. None of the materials, at the dosages tested, was effective against pupae.

In airplane tests nearly complete control of mature larvae was obtained with DDT in oil dispersed at the rate of 0.26 pound per acre, and complete control at rates of 0.44 and 0.48 pound per acre. In the last two tests pupal mortality was 100 per cent and 72 per cent. A dosage of 0.3 pound of DDT per acre applied by a Hochberg-LaMer aerosol generator gave good larval control for a distance of 300 to 400 yards downwind from the emission line, but a dosage of 0.1 pound per acre was ineffective.

Literature Cited

Deonier, C. C., Raun, E. S., Peek, E. H., Davis, A. N., Jr., and Nottingham, E. 1949. A comparison of DDT and other new insecticides for mosquito control. *Mosquito News*. Vol. 9, No. 4.

Goldsmith, J. B., Husman, C. N., Brown, A. W. A., and Sharp, J. F. 1949. Exploratory studies on the control of adult mosquitoes and black flies with DDT under arctic conditions. *Mosquito News*. Vol. 9, No. 3, 93–97.

LaMer, V. K., and Hochberg, S. 1945. Hochberg-LaMer aerosol generator—inventors' model. (OSRD Report 4901.) U. S. Dept. Com. Off. Pub: Bd. Rpt. 15617. [Processed.]

McDuffie, W. C., Sharp, J. F., Cross, H. F., Twinn, C. R., and Wilson, W. M. 1949. The effectiveness of prehatching treatments for the control of arctic mosquitoes. *Mosquito News*. Vol. 9, No. 2, 51–56.

ANNUAL MEETINGS

American Mosquito Control Association with
Virginia Mosquito Control Association

SEE PAGE 180

A COMPARISON OF DDT AND OTHER NEW INSECTICIDES FOR MOSQUITO CONTROL [1]

CHRISTIAN C. DEONIER, EARLE S. RAUN, E. H. PEEK, A. N. DAVIS, JR., AND EDWARD NOTTINGHAM [2]
Bureau of Entomology and Plant Quarantine
Agr. Res. Adm., U. S. D. A.

Screening tests on synthetic organic compounds as acetone-water suspensions and laboratory studies on promising mosquito larvicides are being continued. The methods used follow those reported previously (U. S. Bur. Ent. and Plant Quar. 1947).

In these tests it has been found that heptachlor is slightly less toxic than DDT to larvae of *Anopheles quadrimaculatus* Say, *Culex quinquefasciatus* Say, and *Aedes aegypti* (L.). Parathion has been found more toxic than DDT to these three species of mosquito larvae. The results of these tests are shown in Table 1.

Comparative Toxicity of Methoxy Analog of DDT, TDE, and DDT.—Because of the interest in TDE and the methoxy analog of DDT, which are less toxic than DDT to fish and wildlife, further tests were made on the comparative toxicity of these compounds as acetone-water suspensions to *Anopheles quadrimaculatus, Aedes aegypti,* and *Culex quinquefasciatus.* As in previously reported tests (Deonier *et al.* 1946), TDE and DDT were about equal in toxicity to *Anopheles* larvae and about 10 times as toxic as the methoxy analog of DDT. *Culex* larvae were less susceptible to DDT and TDE but more susceptible to the methoxy analog than were *Anopheles* and *Aedes* larvae (Table 2).

TABLE 1.—Comparative toxicity of parathion, heptachlor, and DDT to larvae of *Aedes aegypti, Culex quinquefasciatus,* and *Anopheles quadrimaculatus.* (3 replications with 20 larvae each at each dilution.)

Material	Percent mortality in 48 hours at indicated dosages					
	0.025 p.p.m.	0.01 p.p.m.	0.005 p.p.m.	0.0025 p.p.m.	0.001 p.p.m.	0.0005 p.p.m.
			Anopheles quadrimaculatus			
Parathion	...	...	...	100	...	100
Heptachlor	100	78	62	57	...	...
DDT	...	100	100	68	...	...
			Aedes aegypti			
Parathion	...	...	...	100	68	58
Heptachlor	100	78	...	43	...	...
DDT	...	100	...	72	...	...
			Culex quinquefasciatus			
Parathion	...	...	...	100	38	12
Heptachlor	40	17	...	...	...	...
DDT	...	83	...	37	...	...

[1] This work was conducted under a transfer of funds, from the Office of the Surgeon General, Department of the Army, and, in part, from the Bureau of Medicine and Surgery, Department of the Navy, to the Bureau of Entomology and Plant Quarantine.

[2] Acknowledgment is made of the advice of W. V. King, in charge of the Orlando, Fla., laboratory of this Bureau, in carrying out these tests.

TABLE 2.—Comparative toxicity of the methoxy analog of DDT, TDE, and DDT to larvae of *Aedes aegypti, Culex quinquefasciatus,* and *Anopheles quadrimaculatus.* (4 replications of 25 larvae each.)

Material	Dosage (p.p.m.)	Percent mortality in 48 hours		
		Culex	*Aedes*	*Anopheles*
Methoxy analog of DDT	0.05	100	78	83
	.025	65	36	45
	.01	–	19	23
	.005	–	9	0
TDE	.01	85	–	–
	.005	35	85	100
	.0025	7	34	37
DDT	.01	82	97	100
	.005	17	96	100
	.0025	7	28	61

Field Tests with Parathion as an Anopheline Larvicide.—Since laboratory tests have shown parathion to be about 10 times as toxic as DDT to fourth instars of *Anopheles quadrimaculatus,* comparative toxicity tests were made in the field with DDT and reduced dosages of parathion to anopheline larvae. Comparisons were also carried out with dusts, emulsions, and oil solutions of parathion to determine the most effective type of formulation.

In the first series of tests, fuel-oil solutions of parathion and DDT were applied as atomized sprays at a dosage of 0.006 pound of the toxicant per acre. The test plots were in drainage ditches overgrown with water hyacinth and had a uniformly distributed larval population, chiefly *Anopheles crucians* Wied. At this dosage DDT gave a very low larval reduction, the average of two tests being 24 percent as compared with 92 percent for parathion. Parathion at 0.001 pound per acre gave an average reduction of 65 percent (Table 3). Fuel oil applied in amounts equivalent to that used with the toxicant caused no mortality.

In the second series of tests three formulations of parathion were applied at a dosage of 0.01 pound per acre. Replications using a 0.25-percent dust in talc were applied with a rotary hand duster. A hand atomizer was used to apply a 0.1-percent solution in fuel oil and a 0.1-percent emulsion. The test plots were small permanent ponds overgrown with vegetation and containing larvae of *Anopheles crucians* and *A. quadrimaculatus.*

The emulsions gave the lowest larval mortality, 90 percent, as compared with

TABLE 3.—Field tests with fuel-oil solutions of parathion and DDT against anopheline larvae.

Dosage per acre		Average number of larvae per dip before treatment		Percent reduction after 24 hours	
Gallons of solution	Pounds of toxicant	DDT	Parathion	DDT	Parathion
0.3	0.025	13	9.0	94	100
		6.7	4.9	90	96
	.0125	10.3	6.2	73	92
		6.0	6.6	67	92
	.006	3.9	7.6	10	91
		4.8	10.6	37	92
6	.0025	...	4.9	...	55
		...	6.4	...	71
		...	4.3	...	66
	.001	...	5.1	...	63
		...	4.8	...	58
		...	6.7	...	75

TABLE 4.—Comparison of dusts, emulsions, and oil solutions of parathion in toxicity to anopheline larvae.

Concentration (Percent)	Treatment	Number of tests	Percent 24-hour mortality	
			Range	Mean
0.25	Dust in talc	2	96–99	97
.1	Oil solution	3	93–100	97
.1	Emulsion	3	82–98	90

97 percent mortality with dusts and oil solutions (Table 4).

In a third series of tests parathion, as a 0.1-percent dust, was carefully applied with a small hand duster at dosages of 0.00125 and 0.006 pound of toxicant per acre. The test plots, ⅛-acre in size, were located in ditches and ponds choked with water hyacinths. The higher dosage was very toxic to the larvae of *Anopheles crucians* and *A. quadrimaculatus* present in the plots, giving in six replicated tests an average reduction of 97 percent in 24 hours. The lower dosage in three replicated tests gave 59 percent larval reduction. A strong wind during the application in some of the tests probably reduced the amount of dust that settled on the plots.

Field Tests on *Culex quinquefasciatus* Larvae.—A small plot (0.1 acre) in a sewage-polluted lake heavily infested with larvae of *Culex quinquefasciatus* was treated with a 1-percent solution of parathion in fuel oil applied with a hand atomizer at the rate of 0.05 pound of toxicant per acre. Counts 24 hours after treatment showed an average of 2.8 larvae per dip, compared with an estimated 500 per dip before treatment, or better than 99 percent larval reduction. In previous tests the *Culex* larvae in the polluted water of this lake had proved difficult to kill with much heavier dosages of DDT.

Summary.—In comparative laboratory tests DDT was slightly more toxic than heptachlor but less toxic than parathion to *Anopheles quadrimaculatus* Say, *Aedes aegypti* (L.), and *Culex quinquefasciatus* Say; TDE and DDT were about equal in toxicity to *Anopheles* larvae and about 10 times as toxic as the methoxy analog of DDT. *Culex* larvae were less susceptible to DDT and TDE but more susceptible to the methoxy analog than were *Anopheles* and *Aedes* larvae. In field tests oil solutions of DDT at 0.006 pound of toxicant per acre gave only 24 percent reduction of anopheline larvae, as compared with 92 percent for parathion. At 0.01 pound per acre, emulsions of parathion gave 90 percent reduction and dusts and oil solutions 97 percent. Parathion in a 1-percent solution in fuel oil applied at 0.05 pound of toxicant per acre was effective against *Culex quinquefasciatus* breeding in sewage-polluted water.

Literature Cited

DEONIER, C. C., H. A. JONES, H. L. HALLER, E. HINCHEY, AND H. H. INCHO. 1946. Mosquito larvicide tests—A resumé of tests of compounds related to DDT against larvae of *Anopheles quadrimaculatus*. *Soap and Sanit. Chem.* 22(11): 118–9, 139.

UNITED STATES BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE. 1947. Results of screening tests with materials evaluated as insecticides, miticides, and repellents at the Orlando, Fla., laboratory from April 1942 to April 1947. *U. S. Bur. Ent. and Plant Quar.* E-733, 235 pp. (Processed.)

DDT LARVICIDES DISPERSED BY SPRAY AND THERMAL AEROSOL PLANES FOR THE CONTROL OF *AEDES DORSALIS* (MEIGEN) AND *AEDES NIGROMACULIS* (LUDLOW).[1]

HARVEY I. MAGY, Vector Control Specialist; ARVE H. DAHL, Chief, Bureau of Vector Control; ARTHUR F. GEIB, Manager, Kern Mosquito Abatement District; SETH J. KIRKWOOD, Vector Control Officer, Grade II.

I. INTRODUCTION

One of the major mosquito breeding areas in the interior of the State of California is the Central Valley which runs north and south for about 400 miles, and averages 40 miles in width. Most of the agricultural practices in the valley are based on irrigation. Millions of acres of natural and planted pastureland and alfalfa are periodically flooded during the spring, summer and fall. There may be as many as ten floodings within one season.

The life cycles of *Aedes dorsalis* (Meigen) and *Aedes nigromaculis* (Ludlow) are suited to this practice of intermittent flooding. Each time a parcel of land is flooded, the larvae of these two species hatch from eggs that have been previously laid on the ground. Within four or five days, under the high temperature conditions prevailing in the valley, the adult mosquitoes emerge in tremendous numbers. The application of larvicides through the use of airplanes is an economical method of controlling these mosquito larvae.

The Bureau of Vector Control, California State Department of Public Health, in cooperation with the Kern Mosquito Abatement District in Kern County evaluated several airplane mosquito larval control techniques from March until September, 1947.

One of the first airplanes equipped with a spray boom with detachable nozzles used for mosquito control was reported by Metcalf, Hess, Smith, Jeffery, and Ludwig (1945). A spray boom was mounted on the trailing edge of the lower wing of a Stearman PT-17 airplane for dispersing solutions for anopheline larval control. Ninety per cent, or better, mortality of *Anopheles quadrimaculatus* Say larvae was obtained when the spray solution was applied at rates of less than 0.03 pound of DDT in Velsicol NR 70 solutions. During the summer of 1946, Geib (1946) in Kern County, California, used a similarly equipped airplane with a spray boom having detachable nozzles. In addition to the spray boom, an engine exhaust venturi was installed on the same plane. It was patterned after the exhaust venturi airplane used by the Tennessee Valley Authority for the control of anopheline mosquitoes as detailed in the report by Krusé and Metcalf (1946). They found that from 0.05 to 0.20 pound of DDT per acre applied by this technique would give adequate control of *A. quadrimaculatus* larvae if the swath width was varied depending upon the density of the vegetation. Geib (1946) used 5% DDT in diesel oil plus 16 ounces of B-1956 as a spreader, applied at rates varying from 0.05 to 0.85 pound DDT with the spray boom on his plane with fair results. One application at the rate of two quarts per acre, with the thermal exhaust aerosol using 20% DDT in light extractives of oil with B-1956 added, gave 100% mortality to fourth instar *Aedes* larvae.

II. OBJECTIVES

The objectives of this study were: (1) to evaluate the use of airplanes for the dispersal of DDT solutions for the control of *A. dorsalis* and *A. nigromaculis*

[1] This report is one of a series on continuing mosquito control operational and biological studies begun in 1946 by the Bureau of Vector Control, Division of Environmental Sanitation, California State Department of Public Health, in cooperation with various mosquito abatement agencies.

larvae under conditions of a routine operational mosquito control program; (2) to determine if the method of applying DDT solutions by means of an airplane thermal exhaust venturi aerosol generator as used by Krusé and Metcalf (1946) for anopheline larval control in impounded water was adaptable to the control of *A. dorsalis* and *A. nigromaculis* larvae occurring in intermittently flooded pasturelands; (3) to compare an airplane equipped with a thermal exhaust aerosol generator for applying larvicides with an airplane equipped with a spray boom for *A. dorsalis* and *A. nigromaculis* larval control.

III. PROCEDURE, EQUIPMENT, AND TECHNIQUES

These studies were conducted during the active 1947 mosquito control season and under the conditions of a routine control program. Any study that failed to give control entailed additional expense and time for the district in order to eliminate the mosquitoes that survived treatment. For this reason, if any one material failed to give control after a few trials, another material was tried. Untreated plots were not used for controls because mosquitoes in the untreated fields would emerge and create a nuisance problem in the district.

Airplane Equipment. Two converted army PT-17 biplanes flown at 90 miles per hour and equipped with 220 h.p. Continental engines were used for these studies. One was equipped with a venturi thermal exhaust aerosol generator and the other as a spray plane.

The thermal exhaust plane was patterned after the airplane used by Krusé and Metcalf (1946) for the control of anopheline larvae in impounded waters; however, there were several modifications. The plane was equipped with a four-inch O.D. exhaust stack, 13 feet long. One flat cone spray nozzle extended into the venturi throat on either side. Chicago Spraying Systems nozzles Numbers 8006, 8010, and 8015 were used. The plane was equipped with a wind-driven Pesco pump and discharged two to four gallons per minute. A Pittsburgh Tropic-Split Case Type, ⅝ inch flow meter was installed.

The spray plane was equipped with a 30 foot long ¾" diameter streamlined boom that was mounted 18 inches below and extended the entire length of the under-surface of the lower wing. A wind-driven pump was used. A flow meter which was the same as that used on the aerosol plane was also installed. There were 20 outlets on the boom having two nozzles at each outlet attached by a "T" to the boom. No. 1 Whirljet Chicago Spraying Systems brass nozzles were used. At the end of three months' service the brass nozzles were unserviceable due to scoring and they were replaced by stainless steel nozzles. After six months, a month before the completion of these studies, the original stream-lined boom was replaced with a ⅝" I.D. steel tube which had 40 openings with one nozzle to each opening.

Materials. The materials used in the thermal aerosol plane were premixed. A General Petroleum solvent designated as PD544C, which is high in aromatics, was the principal solvent used in these studies. DDT was added at the rate of two pounds of DDT to each gallon of solvent. The number of pounds of technical grade DDT per gallon of concentrate was determined to be 1.71 which is equivalent to a 21.4% DDT concentrate when compared with an arbitrary standard of 2.00 pounds per gallon as resulting in a 25% concentrate. Other DDT solutions dispersed with the aerosol plane were DDT in Standard Base Oil WT, in Velsicol NR 70 and AR 60, but these were used to a lesser degree.

In the spray plane studies DDT-Xylene water emulsions were used. The concentrate was obtained from the War Assets Administration.

Vegetation. Natural and planted pastures were the predominant types of fields used in these studies, although some alfalfa fields with poor drainage were also used.

Vegetation in a study area was divided into two types, horizontal and vertical. All broad-leafed vegetation was considered to be horizontal, and all grasses were considered to be vertical. The two types were judged on the basis of their height and density. Density was determined by placing a dipper used in collecting larvae on the ground in the vegetation of the study area, walking back about 10 feet, and determining the area of the dipper handle covered when facing the dipper at right angles to its length. The area of the dipper handle thus obstructed was used as an estimate of the density; e.g., if ⅓ or less of the dipper handle was covered, the vegetation was considered to be of light density; if ⅓-⅔, it was considered to be medium density; ⅔ or more was considered to be heavy density. The percentage of cover over the water surface was estimated to the nearest twenty-five per cent.

Flight Data. The height of flight in an unobstructed field was approximately 15 feet; however, the height was always dependent upon obstructions in the flight path. Numerous studies were flown at 50-foot heights, and several at 75 and 100 feet. The intervals between lines of flight were paced off on the ground by one man at each end of the field, these two men acting as swath markers for the pilot. Fifty, seventy-five and one hundred foot intervals were used in the studies.

Acreage was measured by the pilot while in flight during spray applications, by determining the treatment time with an accumulative time stop watch. The watch was clicked at the beginning and end of each pass of the airplane as the larvicide was turned on or off. Since the plane speed was constant at 90 miles per hour, and the intervals between lines of flight were measured from the ground it was easy to calculate the acreage covered by the plane in any given treatment time and the amount of solution discharged per acre.

Entomological Sampling and Control Evaluation. Following the district's control procedure, the fields for these studies were sprayed in the order of their discovery, irrespective of the larval development. However, fields with pupae were avoided. The larvae were a mixture of *A. dorsalis* and *A. nigromaculis,* the former predominating.

At least two larvae per dip was considered the minimum number of larvae for a field to have if usable for study purposes. Larval stations were selected in multiples of ten in each study. A metal welding rod was used as the station marker and a ½″ by 4½″ by 10″ wood float for holding slides for collecting droplets was placed at five of these stations. A thermometer was attached to the under surface of the float by inserting it into a ¾″ cork plug which in turn was inserted into a ¾″ hole that was drilled in the center of a ½″ by 2⅜″ by 4½″ piece of wood. This piece of wood was screwed sidewise across the width of the float. The stations were widely dispersed in order to cover the area being treated, but they were placed only where larvae could be found. Three dips were taken around each station for a total of sixty dips for most of the studies, both before and after treatment.

The larvae were separated into two groups: first and second instars, and third and fourth instars. Areas with late fourth instar larvae or pupae were avoided. If the same number of larvae or more larvae were present in the post-treatment count than were found in the pre-treatment count in either of the larval groupings, it was presumed that there was no reduction. If on post-treatment inspection the third and fourth instar larval survivors were more numerous than in the pre-treatment count, the excess would be added to the first and second instar survivors and it was therefore assumed that the third and fourth instar had no reduction. In the post-treatment, count pupae that might have appeared were counted separately and added to the third and

fourth instar count. The larval count was made preferably one or two hours before treatment and twenty-four hours after treatment. The effectiveness of treatment was based upon the number of survivors after treatment, or as expressed in the result, as "per cent reduction."

Meteorological Data. For each study meteorological data were obtained. Relative humidity was determined by means of a sling psychrometer, and the wind velocity was determined with an anemometer. Converse and inverse air conditions were determined by placing a thermometer at one foot above the ground and another thermometer at six feet above the ground. The difference in temperature would indicate whether the air was rising or falling.

Water and Biological Factors. The temperature of the water was determined by placing a thermometer at the bottom of three of the floats. The average of these three readings was recorded. Water depth was estimated to the nearest 4 inches as the average depth of the water area where the larvae were present. The coverage of algae was noted and estimated to the nearest 25%, whether it was on the surface, sub-surface, bottom or a combination of these levels in the water. The presence or absence of flotage was noted, and estimated to the nearest 25%.

Droplet and Chemical Studies of DDT Recovery. To attempt to correlate the effectiveness of control and droplet penetration through the vegetation, magnesium oxide coated slides were placed on five of the floats in the vegetation. The mean diameter, the mass median diameter, and the number of droplets per square centimeter were determined microscopically. Three clean slides were placed on each of four of the floats, (to give an aggregate area totaling one quarter of a square foot). After the DDT solution was deposited the slides were collected and the clean ones were chemically analyzed for DDT. The results were reported in terms of pounds DDT recovered per acre and the per cent recovery was then determined.

IV. DISCUSSION OF RESULTS

Comparative Toxicity of Spray vs. Aerosol. The results of the reduction of the larval population following treatment for the spray and aerosol studies expressed on an average basis are summarized in Table 1. The studies are grouped in three DDT dosage ranges. The reduction of larvae is further broken down into instar groupings.

Those studies conducted under favorable vegetative conditions are listed separately from those done under adverse vegetative conditions. Favorable vegetative conditions were presumed to prevail when the density of the vegetation was light or medium and 75% or less of the water surface was covered; when the density was heavy and 100% of the water surface area was covered with vegetation, the vegetative conditions were considered to be adverse.

In the DDT-Xylene spray plane studies the solutions were dispersed as water emulsions at rates varying from 0.5 to 1.4 gallons of 2.5% to 5% solutions. The results of these studies are based upon the pounds of DDT dispersed per acre.

In the DDT-Xylene water emulsion spray studies better than 88% control was obtained for all larval stages when more than 0.30 pounds of DDT was applied per acre. At this dosage those studies done under favorable vegetative conditions gave 100% control for first and second instars, and 93% control for third and fourth instar larvae. Those conducted under adverse vegetative conditions involving first and second instar larvae gave 96% control, while third and fourth instar larval studies had 78% control. Below 0.30 of a pound DDT per acre the first and second instar reduction was 81% under favorable vegetative conditions and 55% under adverse vegetative conditions; the third and fourth instar reduction was 36% or less under all vegetative conditions.

In the aerosol studies, however, the dosage of DDT, the vegetative conditions, and the relative susceptibility of the larval groupings were not usually demonstrable.

Table 1—Comparative toxicity of DDT in xylene emulsion spray and in thermal aerosols to *Aedes* spp. larvae under favorable and adverse vegetative conditions. Kern Mosquito Abatement District, 1947.

		0.20 – 0.29 Lbs. DDT/Acre				0.30 – 0.39 Lbs. DDT/Acre				0.40 – 0.49 Lbs. DDT/Acre			
		1 & 2 Instar		3 & 4 Instar		1 & 2 Instar		3 & 4 Instar		1 & 2 Instar		3 & 4 Instar	
Materials	Vegetative Conditions	No. of stud.	Av. % reduct.	No. of stud.	Av. % reduct.	No. of stud.	Av. % reduct.	No. of stud.	Av. % reduct.	No. of stud.	Av. % reduct.	No. of stud.	Av. % reduct.
DDT-xylene water	Favorable	5	81	4	36	8	100	7	93	7	100	3	100
emulsion spray	Adverse	5	55	5	10	3	96	4	78	3	100	4	96
	Total	10	67	9	22	11	99	11	88	10	100	7	98
PD544C + 16 oz.	Favorable	–	–	–	–	1	62	1	0	2	4	1	0
B-1956 per 100 gal.	Adverse	–	–	–	–	–	–	–	–	–	–	–	–
aerosol	Total	–	–	–	–	1	62	1	0	2	4	1	0
+5% emulsifying	Favorable	–	–	2	50	2	97	4	54	–	–	–	–
agents *	Adverse	1	100	1	95	1	100	–	–	–	–	–	–
aerosol	Total	1	100	3	65	3	98	4	54	–	–	–	–
Standard base	Favorable	–	–	–	–	1	100	–	–	2	71	1	100
oil WT aerosol	Adverse	–	–	–	–	–	–	–	–	1	100	–	–
	Total	–	–	–	–	1	–	–	–	3	81	1	100

* 1½% B-1956, 3½% Igepol.

Solutions of DDT in PD 544C gave very erratic results. With 16 ounces of B-1956 per 100 gallons added as a spreading agent, poor results were obtained. Upon the addition of 5% of an emulsifying agent, containing 1½% B-1956 and 3½% Igepol, the relative susceptibility of the early instars compared to the later instars was demonstrable, but the effect of increased dosage of DDT was not. This latter solution when diluted with water or diesel oil failed to give control in several experimental trials.

Three studies with DDT in Standard Base Oil WT applied as an aerosol generally gave 100% control and two studies gave an average of 71% control, but the relative susceptibility of the earlier larval stages compared to the later stages and the effect of adverse vegetative conditions upon control were not demonstrable. More trials with this material were planned, but the season ended before they could be attempted. Velsicol NR 70 and AR 60-DDT aerosol solutions were tried several times but with very erratic results. These materials were too expensive, due to high shipping costs, to be used economically in California. Additional studies with aerosol solutions are advisable before definite conclusions can be drawn.

DDT-Xylene Water Emulsion Toxicity Curves

Two experimental toxicity curves were obtained when the pounds of DDT per acre applied as DDT-Xylene water emulsion sprays under adverse and favorable vegetative conditions were plotted against the percentage of reduction of third and fourth instar larvae, as presented in Figure 1.

To obtain a dosage of 0.40 of a pound DDT per acre, one gallon of 5% solution was used; for 0.30 of a pound, three quarts of a 5% solution were used; for

0.20 of a pound, two quarts of a 5% solution or one gallon of a 2.5% solution were used; and for 0.10 pound per acre, two quarts of a 2.5% solution were used. For intermediate dosages, intermediate volumes other than those given above were used.

The break in toxicity for the studies conducted under favorable conditions is between 0.25 and 0.30 pound, and under

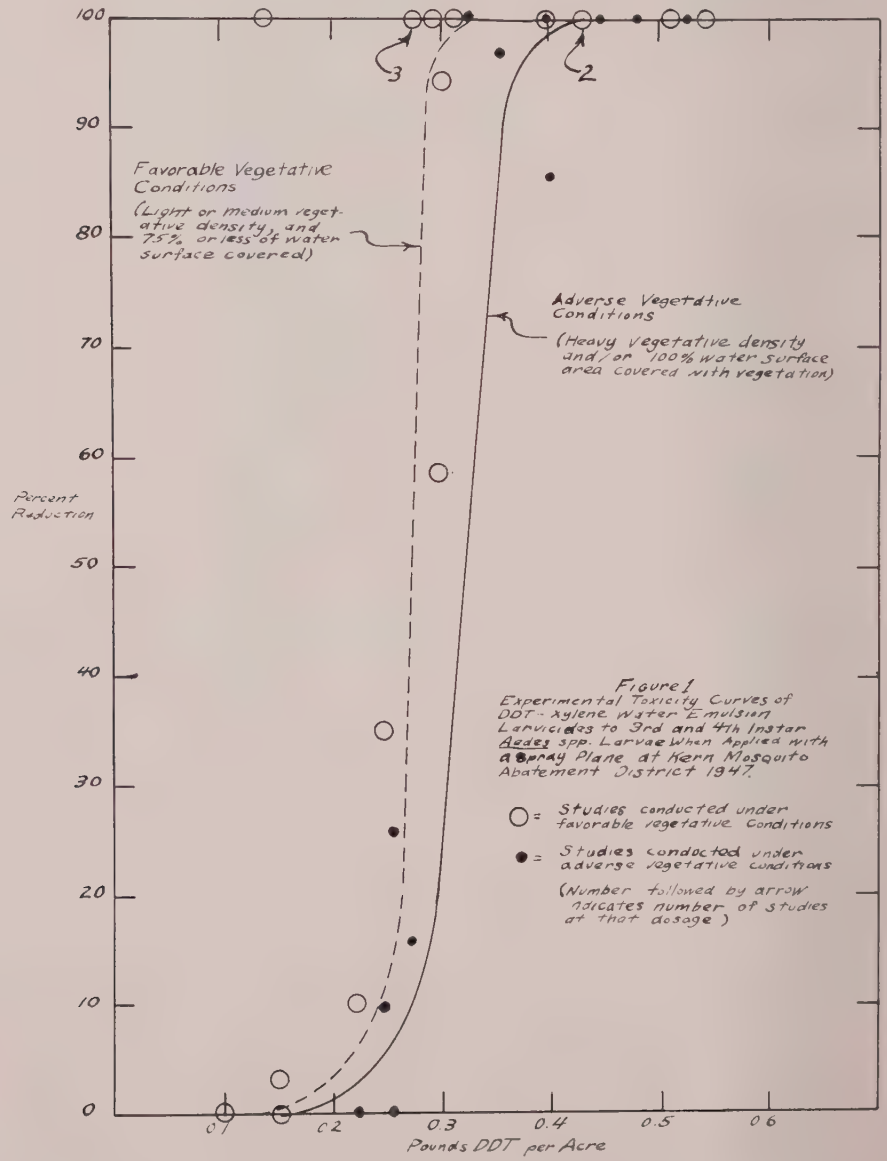


Figure 1
Experimental Toxicity Curves of DDT-xylene Water Emulsion Larvicides to 3rd and 4th Instar *Aedes* spp. Larvae When Applied with a Spray Plane at Kern Mosquito Abatement District 1947.

adverse conditions between 0.35 and 0.40 pound of DDT per acre. Larval reduction of 95% was obtained at 0.30 of a pound DDT per acre under favorable vegetative conditions, and under adverse vegetative conditions, 0.40 of a pound had to be applied in order to obtain 95% larval reduction.

The same relationship with first and second instars is shown in Figure 2. The break in toxicity is not so clear-cut but the trend is indicated. It appears that under

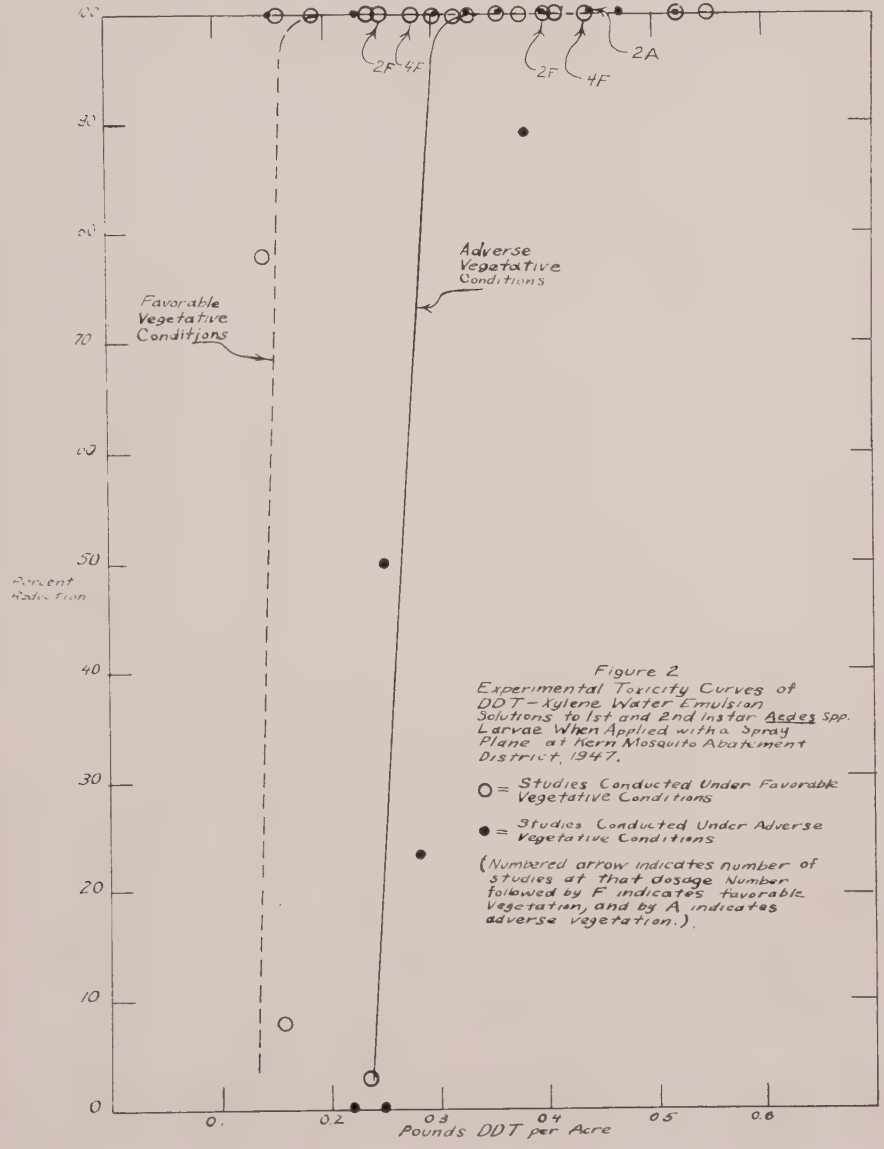


Figure 2
Experimental Toxicity Curves of DDT-Xylene Water Emulsion Solutions to 1st and 2nd Instar Aedes Spp. Larvae When Applied with a Spray Plane at Kern Mosquito Abatement District, 1947.

○ = Studies Conducted Under Favorable Vegetative Conditions

● = Studies Conducted Under Adverse Vegetative Conditions

(Numbered arrow indicates number of studies at that dosage. Number followed by F indicates favorable vegetation, and by A indicates adverse vegetation.)

favorable vegetative conditions the mortality curve breaks below 0.15 and 0.20 pound of DDT per acre, and under adverse vegetative conditions the break appears to be between 0.25 and 0.35 pound of DDT per acre.

Effective Swath Width for Spray Plane Applications of DDT-Xylene Water Emulsion

Out of eleven studies in which DDT-Xylene water emulsion was applied with a spray plane between 0.30 to 0.40 pound of DDT per acre at various intervals between lines of flight where vegetative conditions were favorable, six of the studies with a resultant 75-foot swath gave an average of 97% control. Four of the studies at 50 foot flight intervals gave an average of 99% control. One flight at 100 foot intervals gave 55% control. Those studies flown at 75 foot flight intervals were almost as effective as those flown at 50 foot flight intervals and were more economical as the plane was able to fly 50% more acreage with the same spray load.

Recovery of DDT and Mortality

An experimental toxicity curve was obtained by plotting the pounds of DDT per acre recovered after spraying with the xylene-water emulsion against per cent of reduction of third and fourth larval instars. This curve was found to correspond roughly with the toxicity curve in figure 1, based on pounds of DDT actually applied.

It would appear from this curve that to obtain a 90% larval reduction, 0.30 pound of DDT would have to be applied, of which 22% or 0.064 pound of DDT could actually be recovered.

Measured Factors

As previously shown there appears to be a correlation of the reduction of larvae following treatment with DDT-Xylene water emulsion with the amount of DDT applied per acre, with the vegetative conditions, and also with the amount of DDT recovered. The other measured factors in the spray studies were not correlative. These included the relative humidity, temperature of water and air, the pH of the water which varied from 6.0 to 8.0, the water depth, and the presence or absence of algae and flotage. In the aerosol studies there were too few studies with each material to enable a correlation of the measured factors.

Other pertinent facts were obtained. In the DDT-Xylene water emulsion spray studies the droplets varied from 10 to 400 microns in size, the bulk of the drops falling between 40 to 150 microns. The mean diameter varied from 30 to 195 microns, the average being 68 microns; the mass median diameter varied from 120 to 260 microns, the average being 198 microns.

In the aerosol studies the droplets varied from 5 to 300 microns in diameter, while the bulk were less than 100 microns. The mean diameter varied from 15 to 115 microns, the average being 51 microns; the mass median diameter varied from 53 to 260 microns, the average being 132 microns.

The percentage of DDT recovered as determined by chemical analysis varied from 5.0% to 57.9% in the aerosol studies with an average of 20.7%, and for the DDT-Xylene emulsion spray plane studies from 4.6% to 26.0%, with an average of 17.9%.

V. SUMMARY

The method of applying DDT-aerosol solutions by means of an airplane thermal exhaust venturi generator, as developed by Krusé and Metcalf (1946) of the Tennessee Valley Authority for anopheline larval control, was not adaptable for the consistent control of *A. dorsalis* and *A. nigromaculis* larvae occurring in intermittently flooded pastures in the Sacramento-San Joaquin Valley of California. A PT-17 plane modified as a boom-spray plane was adaptable as a means of dispersing DDT larvicides for obtaining satisfactory control of *A. dorsalis* and *A. nigromaculis* larvae.

DDT-Xylene water emulsion dispersed by a spray plane above 0.30 pound of DDT per acre gave 95% and above larval reduction to *A. dorsalis* and *A. nigromaculis* 3rd and 4th instar larvae under favorable vegetative conditions. In areas where the vegetative conditions were adverse, over 0.40 pound of DDT in this solution gave better than 95% larval reduction. For first and second instar larvae of *A. dorsalis* and *A. nigromaculis* 0.20 pound of DDT under favorable vegetative conditions, and 0.30 pound of DDT under unfavorable conditions gave 100% control.

Seventy-five-foot swath intervals flown by the spray plane were almost as effective as 50-foot swath intervals and would be more economical. In the spray plane studies DDT dosage per acre, type of vegetation, and amount of DDT recovered were correlated with mortality. None of these factors were correlated with larval control in the aerosol studies.

Acknowledgments

The authors wish to thank the following individuals for their helpful assistance on this project: Grafton Campbell and Thor A. Holm, Bureau of Vector Control, California Dept. of Public Health; Gordon F. Smith, Entomologist, and Dale F. Knopf, pilot, Kern Mosquito Abatement District; Dr. R. L. Metcalf, University of California, who was kind enough to visit this project and offer valuable suggestions pertaining to the technical aspects; Dr. W. M. Hoskins, University of California, who gladly offered technical information; T. E. Hillis, chemist, Div. of Laboratories, California Dept. of Public Health; and Miss Geraldine B. Edwards, Senior Public Health Analyst, California Department of Public Health, who generously contributed her help to certain statistical aspects of this project.

Literature Cited

Geib, A. F. 1946. Dr. Morris Mosquito Abatement District airplane work. Proc. 15th Ann. Conf. *Calif. Mosq. Cont. Assoc.* 125–128.

Krusé, C. W. and Metcalf, R. L. 1946. An analysis of the design and performance of airplane exhaust generators for the production of DDT aerosols for the control of *Anopheles quadrimaculatus*. *U. S. Pub. Hlth. Rpts.* 61 (32):1171–1184.

Metcalf, R. L., Hess, A. D., Smith, G. E. Jeffery, G. M., Ludwig, G. W. 1945. Observations on the use of DDT for the control of *Anopheles quadrimaculatus*. *U. S. Pub. Hlth. Rpts.* 60(27):753–774.

JEEP EXHAUST VENTURI AEROSOL

ROBERT W. JONES, III [1] and JAMES R. HOLTEN [2]

Thermally produced aerosols have come to be rather widely used for mosquito control in California. The limitations imposed by wind, temperature, and humidity are recognized and the aerosols are used within these limitations as an adjunct to basic larval control measures in order to control flights of mosquitoes that do emerge.

The "plumber's nightmare" devised by Raley (1947) and adapted by Crowe (1948) has been most frequently used, because of its low cost as compared to the cost of the large commercial generators. It is a simplified version of the National Defense Research Committee aerosol generator. The venturi aerosol discussed here

[1] Vector Control Specialist, Bureau of Vector Control, California State Dept. Public Health.

[2] Vector Control Officer, Grade I, Bureau of Vector Control, California State Dept. of Public Health.

is also a modification of the National Defense Research Committee design.

There are two primary considerations to be taken into account in the design of venturi atomizers. The diameter of the venturi throat must maintain a balance between back pressures on the engine and effective break-up of the insecticide into a mist or spray. In order to obtain an effective break-up of the liquid, throat velocities of from 1000 to 1400 feet per second must be maintained. The rapid expansion of the exhaust gases through the divergent tail section of the venturi reduces the back pressures obtained sufficiently to allow for continuous operation of the unit without undue overheating or loss of power.

In addition, the type of liquid injection should allow for trouble-free operation and ease of maintenance. Gravity feed injection through ¼" i.d. copper tubing has proved sufficient for this type of unit. Radial injection in the venturi throat has the disadvantage of rapid carbonization due to the semi-vacuum created at the point of injection. Coaxial injection does not create such a "dead space" and improves performance materially because it permits high liquid flow rates with gravity feed even though the pressure at the venturi throat exceeds atmospheric pressure.

Drooling of such an exhaust unit due to non-atomization of the liquid may reduce its efficiency by as much as 50%. Such drooling is the result of impingement of the particles on the divergent wall of the tail section of the venturi and the lack of sufficient velocity of the exhaust gases to rip the liquid away from the wall again. If the exit velocity is maintained above 250 to 300 feet per second, such drooling is eliminated. It follows then, that with the throat velocities used in venturi generators, the exit diameter should never be more than twice the throat diameter.

With these thoughts in mind, trials of the National Defense Research Committee aerosol and the "plumber's nightmare" were run in an attempt to determine which was the most effective jeep aerosol unit. The NDRC design was selected and certain modifications were developed for it. The modifications of the original design made in this unit were to reduce back-pressure on the engine of the civilian jeep and to make the unit easier to clean and maintain. This unit, in more than a year's operation, seems to be from 10% to 15% more efficient than the "plumber's nightmare" because of complete atomization of the insecticide and consequent elimination of drooling. This has a further advantage in that the unit may be used in close proximity to lawns and shrubs with minimal danger of foliage "burning." It is a little more complicated to construct than is the "plumber's nightmare," but still may be built by an enterprising mechanic with a minimum of effort.

Venturi Fabrication and Installation:

Commercial bids for the manufacture of one of the units were about $30.00, while the cost to construct the unit in our shop was about $6.00 for labor and $5.00 for materials, a total of $11.00. The list of materials required is as follows:

One ⅛" black pipe tee

One ⅛" black pipe plug

One brass ¼" pipe to ¼" tubing connection

One piece ¼" copper tubing 5" long

One piece 1¼" black pipe 2" long, threaded one end

One 1¼" black pipe coupling

In addition to these materials for the venturi unit itself, the following are needed for completing the installation on the jeep:

4½' of ¼" i.d. copper tubing for feed line

Four brass ¼" pipe to ¼" tubing connections

One 1¼" black pipe nipple 10" long threaded both ends

One 1¼" black pipe tee

One brass ¼" globe valve
One storage tank

The measurements (Fig. 1) of this unit are the same as those given in the National Defense Research Committee report (1945) except for the following:

1. The throat of the venturi was increased from 7/16" i.d. to ½" i.d. to eliminate excess back pressure. Measured back pressure was obtained at any engine speed which would allow efficient operation of the exhaust venturi generator.

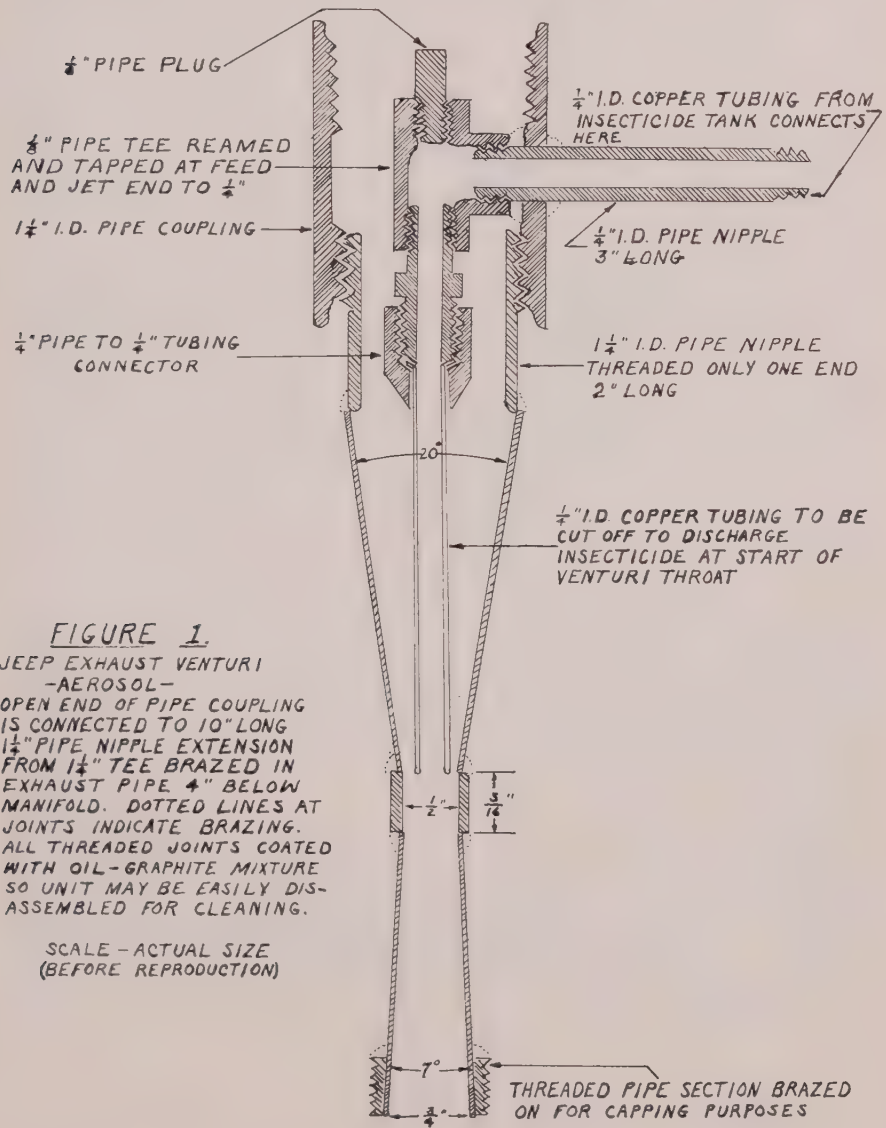

¼" PIPE PLUG
⅜" PIPE TEE REAMED AND TAPPED AT FEED AND JET END TO ¼"
1¼" I.D. PIPE COUPLING
¼" PIPE TO ¼" TUBING CONNECTOR
¼" I.D. COPPER TUBING FROM INSECTICIDE TANK CONNECTS HERE
¼" I.D. PIPE NIPPLE 3" LONG
1¼" I.D. PIPE NIPPLE THREADED ONLY ONE END 2" LONG
20°
¼" I.D COPPER TUBING TO BE CUT OFF TO DISCHARGE INSECTICIDE AT START OF VENTURI THROAT
½"
3/16"
7°
¾"
THREADED PIPE SECTION BRAZED ON FOR CAPPING PURPOSES

FIGURE 1.

JEEP EXHAUST VENTURI
-AEROSOL-
OPEN END OF PIPE COUPLING IS CONNECTED TO 10" LONG 1¼" PIPE NIPPLE EXTENSION FROM 1¼" TEE BRAZED IN EXHAUST PIPE 4" BELOW MANIFOLD. DOTTED LINES AT JOINTS INDICATE BRAZING. ALL THREADED JOINTS COATED WITH OIL-GRAPHITE MIXTURE SO UNIT MAY BE EASILY DISASSEMBLED FOR CLEANING.

SCALE - ACTUAL SIZE
(BEFORE REPRODUCTION)

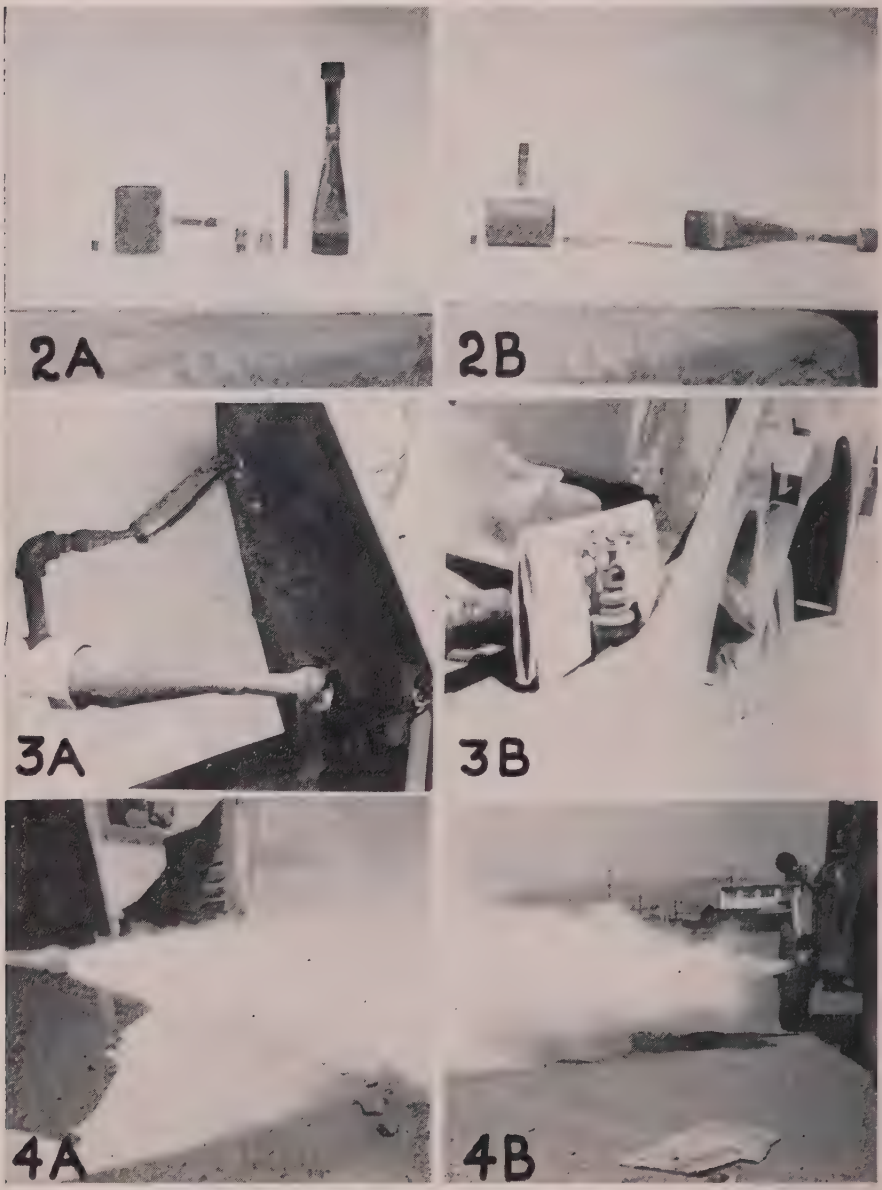


Figure 2A. Unit completely disassembled.
Figure 2B. Unit partially disassembled.
Figure 3A. Unit mounted on jeep.
Figure 3B. Control valve.
Figure 4A & 4B. Unit in operation.

2. The single-size tube assembly used (Fig. 2) was substituted for the original curved two-size jet tube so that it could be dismantled and reamed free of carbon with a minimum of tools and time.

3. The fixed mounting in lieu of the flexible mounting permits constant availability and ease of operation. The control valve on the driver's side of the jeep allows one man to both drive and operate the venturi (Fig. 3).

The convergent and divergent sections of the venturi can most satisfactorily be formed on a mandrel turned to proper size.

When installing the unit, the exhaust pipe of the vehicle is cut four inches below the manifold and a section of the exhaust pipe long enough to allow the insertion of a tee joint is removed. A 1¼" black pipe tee is then brazed into this opening. A 1¼" pipe nipple 10" long extends from the tee joint and the venturi unit is screwed onto this extension. Black pipe is used rather than galvanized for ease of brazing parts. An oil and graphite mixture is used to coat all threaded joints so that they may be broken easily even after heating, when the unit must be dismantled for cleaning. The supply tank may be of any size, shape, and capacity, but should be placed so that it is at least 18" to 24" above the venturi throat. The tank is normally placed in the rear of the jeep above the fender well.

Operation:

In operation (Fig. 4), the unit may be controlled to produce a dry fog (*aerosol*) or a wet fog (mist) by the gravity feed line control valve which controls the volume of insecticide introduced into the venturi. The jeep exhaust pipe is plugged with a 1¼" pipe plug when the venturi is in operation. A 1¼" i.d. pipe coupling is brazed onto the exhaust pipe to take this plug. When the venturi is not in use, it is capped with a ¾" pipe cap, and the exhaust pipe unplugged.

SUMMARY:

A jeep exhaust venturi aerosol based on the National Defense Research Committee design, but employing certain modifications, is described. The basic concepts of venturi aerosol design and the design modifications made to improve operation and ease the maintenance load of this unit are discussed. Photographs and a drawing illustrate the component parts of the unit and its installation on a jeep.

Literature Cited

Raley, Theodore G. 1947. California ground thermal aerosol generator. *Mos. News,* 7:2, 58–63.

Crowe, Ralph. 1948. The plumber's nightmare "grows up" and now has a colt. *Mos. News,* 8:3 110–111.

National Defense Research Committee. 1945. Development of an exhaust DDT aerosol generator for the ¼ ton, 4 x 4 truck ("Jeep"). OSRD No. 6301, NRC Insect Control No. 139.

REMEMBER THE MEETINGS!

SEE PAGE 180

SPRAY EQUIPMENT FOR C-47, UC-64, AND L-5 AIRPLANES [1]

C. N. HUSMAN

U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

Spray booms were first attached under the wings of an airplane, a TBM, on Guadalcanal for the Navy [2] in the fall of 1944. This equipment gave a wider swath width, more uniform distribution, and a better droplet spectrum than previous equipment. Early in 1945 similar equipment was made for a TBM at the Banana River Air Base, Cocoa, Fla., and for an L-5 at the Orlando, Fla., laboratory of the Bureau of Entomology and Plant Quarantine. In March 1948 wing spray booms, which are now considered one of the standard types of installation (U. S. War Dept. 1946; U. S. Bur. Ent. and Plant Quar. 1946; and Husman, Longcoy and Hensley 1947), were designed for and installed on a C-47 plane. A similar installation had been made in 1947 on a Norseman (UC-64)[3] for use in Alaska. A check valve was also developed for the L-5 spray booms to prevent drainage of the spray bars when the supply valve was closed. A brief description of these installations and the calibration of each are given in this paper.

Equipment for C-47.—No structural changes in the C-47 plane were necessary for the installation of the spray boom, and it could be installed or removed in about 4 hours. The equipment caused no change in flight characteristics, but the drag therefrom reduced the cruising speed by 10 m.p.h.

The spray solution was carried in two rubber-lined, 375-gallon gasoline tanks mounted one behind the other in the front of the cargo compartment. Each tank was mounted on a separate wooden cradle, padded with rubber stripping. Each tank was secured to its cradle with cables and turnbuckles, and each cradle was bolted to the floor of the cargo compartment.

The spray system (fig. 1) consisted of two wing booms, each 18 feet long, and one center-section boom 8 feet 6 inches long constructed of chrome-molybdenum-steel tubing of 1.25-inch (o.d.) by 0.035-inch wall thickness. Spray-outlet holes of No. 52 wire-drill size (0.064 inch) were spaced 2½ inches apart the full length of each boom, on the back side. The booms were held securely in place by hanger brackets 18 inches below the wings and center section. The wing units were not rigid and therefore flexed with the wing. Drip-guard plates were installed on all hanger brackets to prevent spray material from working up the rear supports onto the ailerons.

The spray solutions were delivered from the tanks to the booms by five 24-volt, electric fuel-transfer pumps, each with a capacity of 850 gallons per hour at a pressure of 14 pounds per square inch. The pumps and an electric relay system were mounted on a platform secured to the cradle mount, two of the pumps being connected to each wing boom and one to the center-section boom. A switch box containing a control switch for each spray boom was mounted on the rear wall of the pilot's compartment within easy reach of the co-pilot. The supply line from each tank entered a manifold that had one outlet for each pump. A check valve was installed in the supply line from the rear tank to eliminate drainage from the front to the rear tank. Aluminum tubing, 1¼ inches in diameter, connected the mani-

[1] This work was conducted under funds allotted by the National Military Establishment to the Bureau of Entomology and Plant Quarantine.

[2] By C. N. Husman (naval technician), Lt. J. D. Maple (USNR), and Lt. (jg.) S. F. Fallander (USNR).

[3] Most of this installation was made for the Alaska research group by Captain W. C. Stevens, Fort Richardson, Alaska.

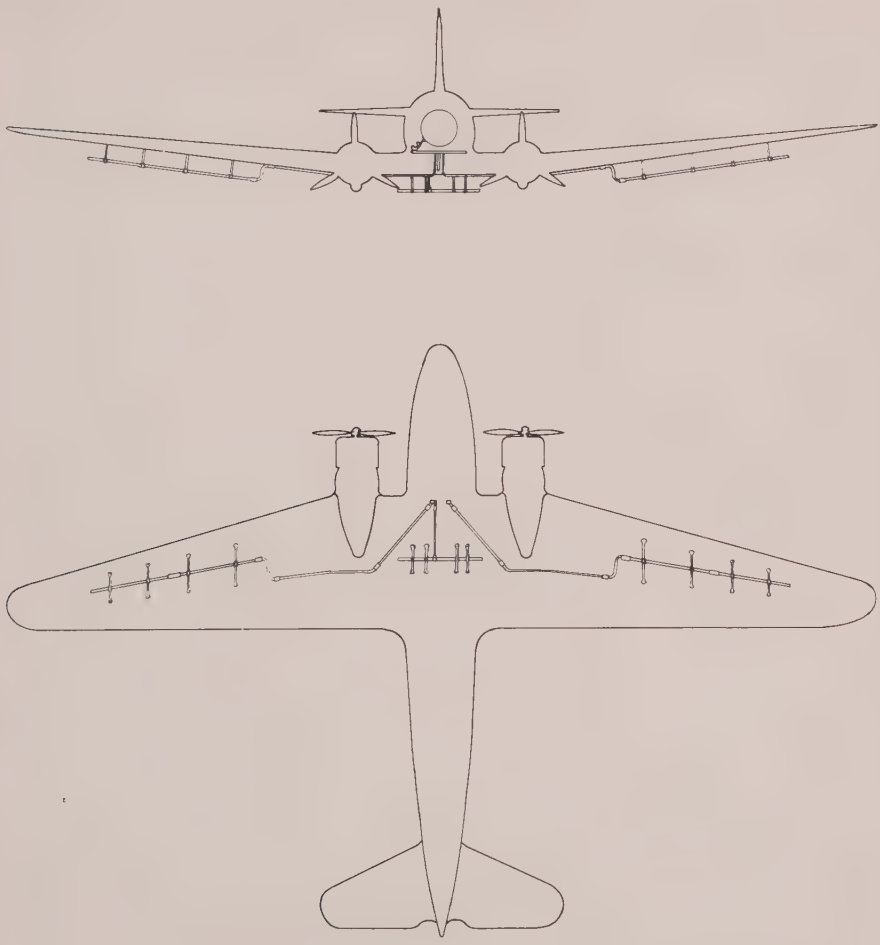


Fig. 1.—Schematic drawing of the wing-boom installation for the C-47 airplane.

fold to the spray booms. The connecting tubing extended through the radio-compartment floor and then through the deicer doors on the bottom of the fuselage, making it unnecessary to cut the fuselage skin. All tubing connections were made with oil-resistant rubber hose and clamps.

The equipment was calibrated by flying the plane directly into the wind at an altitude of about 50 feet. Calibration runs (fig. 2) were made with wind below 1 mile per hour at a delivery rate of 1 pint per acre. White squared paper and glass slides coated with magnesium oxide were placed every 100 feet at right angles to the line of flight so that the swath width, droplet size, and the number of droplets reaching the ground per square inch could be determined. The spray solution contained 0.5 percent of red dye for calibration purposes. The calibration data are given in Table 1.

The number of droplets per square inch visible on the paper, as determined from

TABLE 1.—Calibration data for the C-47, the UC-64, and the L-5, with and without an impinging plate. (Sprays containing 20% of DDT, 40% of Velsicol AR-50,[1] and 40% of fuel oil were used.)

Item	C-47	UC-64	L-5	
			With impinging plate	Without impinging plate
Air speed, miles per hour	140	120	90	90
Swath width, feet	800	300	100	100
Droplet size (mass median diameter), microns	136	156	98	224
Diameter of droplets (microns):				
0–50	18	17	39	23
51–100	59	45	52	33
101–150	9	24	8	20
151–200	6	16	1	17
201–250	.2	0	0	4
251–500	0	0	0	4
Delivery rate, gallons per minute	28.6[2]	9.1	2.3	2.3
Acres covered per minute	225.9	72.6	18.2	18.2
Pay load, gallons	600	100	42	42

[1] Chiefly mono- and dimethyl-naphthalenes.
[2] Two pumps in operation, each with a capacity of 14.3 gallons per minute.

an average of two calibration runs with the C-47, was as follows:

Stations (100-foot intervals)	Average number of droplets per square inch
0	4
100	4
200	24
300	48
400	100
500	88
Center	
600	160
700	160
800	128
900	44
1,000	32
1,100	0

The electrical connections were arranged so that each pump could be operated separately. Each pump was capable of delivering ½ pint per acre; thus the delivery rate could be adjusted easily to give dosages ranging from ½ to 2½ pints of solution per acre. When a dosage of ½ pint was applied, one pump was connected by a Y joint to both wing booms. In addition to this wide dosage range at the same air speed and swath width, the two supply tanks could be emptied independently. Therefore, two different spray solutions could be loaded at one time and sprayed in the same flight.

It was found that the center-section boom was not necessary to insure coverage of the central portion of the swath. Consequently, this boom was used only for applying the higher dosages.

In field tests the beginning of each swath was marked for the pilot by smoke bombs and the pilot then flew a straight line, using both a compass and scaled maps or scaled photographs. In each test a preliminary "dry run" was made to establish the compass course and to locate check points at the end of the run. This method not only proved satisfactory but was the only feasible way to maintain accurate swath intervals where runs were 4 to 5 miles long.

The original plans for construction of the equipment could not be followed because streamlined tubing and special solenoid valves were not available. The use of streamlined tubing for constructing the spray booms and hanger brackets would have minimized the drag and re-

Fig. 2.—C-47 plane distributing spray for the calibration of the equipment.

sulted in little loss of flying speed. In addition, a check valve similar to the one designed for the L-5 would stop drainage of the booms after the pumps are shut off, and thus prevent loss of spray material.

Equipment for UC-64.—The UC-64, or Norseman, plane was equipped with 12-foot spray booms mounted on the struts under each wing. Six holes, No. 48 wire-drill size (0.076-inch), were spaced equidistant along each boom. The insecticide was carried in a 200-gallon tank, which was mounted in a wooden cradle and bolted to the floor of the cargo compartment. An electrically driven fuel pump (Pesco G-10) with a maximum delivery rate of 450 gallons per hour was used for the pressure system. The pump was equipped with an adjustable pressure by-pass valve, making it possible to alter the output. A toggle switch to operate the pumps was mounted on the instrument panel within easy reach of the pilot.

The calibrations (Table 1) were made under the same conditions as for the C-47.

Equipment for L-5.—The L-5 plane was equipped with the standard spray-boom equipment. Each boom had 10 holes, No. 70 wire-drill size (0.028-inch), all of which were used for dosages of 1 pint per acre. When dosages of ½ pint were needed, half the holes were closed with hose clamps.

A ball check valve with an adjustable tension spring was designed and mounted on each boom to eliminate the drainage of the spray solution from the lines after the tank valve was closed. The unit could be adjusted to hold back pressures of 5 to 20 pounds per square inch, as needed.

The L-5 equipment was tested both with and without impinging plates on the booms. The impinging plates lowered the mass median diameter and reduced the number of undesirable large drops (Table 1).

Summary.—Spray-boom equipment was developed for a C-47, using electric fuel-transfer pumps for the pressure system. Five pumps were installed, each of which would deliver 14.3 gallons per minute or the equivalent of ½ pint of spray per acre for a swath of 800 feet. Swath-width and droplet-size calibrations were made with three planes, a C-47, a UC-64, and an L-5, using sprays containing 20 percent of DDT, 40 percent of Velsicol AR-50 (chiefly mono- and dimethyl-naphthalenes), and 40 percent of fuel oil, delivered at the rate of 1 pint per acre. The C-47, flown at 140 m.p.h., gave a droplet size of 136 microns mass median diameter. The UC-64, or Norseman, flown at 120 m.p.h. gave a 300-foot swath and a droplet size of 156 microns mass median diameter. Droplet size (mass median diameter) from the L-5 with the impinging plate was 98 microns and without the plate, 224 microns. A check valve was installed on the L-5 plane to prevent the drainage of the spray solution from the lines after the tank valve was closed.

Literature Cited

HUSMAN, C. N., LONGCOY, O. M., AND HENSLEY, H. S. 1947. Equipment for the dispersal of DDT insecticides by means of aircraft. *U. S. Bur. Ent. and Plant Quar.* ET-228, 17 pp. (Processed.)

UNITED STATES BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, ORLANDO, FLA., LABORATORY. 1946. DDT and other insecticides and repellents developed for the armed forces. *U. S. Dept. Agr. Misc. Pub.* 606, 71 pp.

UNITED STATES WAR DEPARTMENT. 1946. Spraying of DDT from aircraft. *War Department TB Med.* 200, 25 pp.

THE OCCURRENCE OF *AEDES (OCHLEROTATUS) THELCTER* DYAR IN THE FLORIDA KEYS [1]

ERNESTINE BASHAM THURMAN,[2] JAMES S. HAEGER,[3] AND JOHN A. MULRENNAN [4]

Dyar (1928) and Matheson (1944) have recorded *Aedes thelcter* Dyar as a relatively rare mosquito of Texas. This species has been reported by entomologists at the Texas State Health Department (1944) as breeding in temporary rain pools in the Lower Rio Grande Valley and up the coast as far north as Nueces County, Texas, with occasional specimens collected in the southwestern counties. The largest numbers have been taken in light traps around Corpus Christi, Texas.

The first positive record of *A. thelcter* Dyar in Florida is that of a series of four males and four females reared from larvae collected on Long Key, Monroe County, December 5, 1947. The breeding place was a temporary rain pool formed by a shallow depression in the Key Largo limestone strata. According to Cooke (1945) these strata were originally coral reefs along the outer edge of the Floridian Plateau which are characteristic of the Upper Keys region extending from Sands Key to Loggerhead Key on the west. Abundant growth of Florida poisontree (*Metopium toxiferum* (L.) Krug and Urban), gumbo limbo (*Bursera simaruba* (L.) Sarg.), scrub pithecellobium (*Pithecellobium unguis-cati* (L.) Benth), boxleaf eugenia (*Eugenia myrtoides* Poir.), century plants (*Agava spp.*) and several species of tropical vines surrounding the pool provided a canopy of dense shade. The pool, located in the inner edge of a buttonwood (*Conocarpus erecta* L.) transition zone between a hardwood forest and a black mangrove (*Avicennia nitida* Jacq.) brackish-swamp, was filled with a thick mat of purslane sesuvium (*Sesuvium portulacastrum* L.). It was, however, apparently free of permanent aquatic vegetation. Century plants were abundant around the borders and in the shallow areas of the pool. These plants, common over the forest floor in this area, are typical of xerophytic conditions but are tolerant to temporary floodings. Holes of the land-crab were prevalent in the depression. Tested samples of the marl-like soil from the breeding site gave a pH reading of 6.2 which is more acid than is usual for mosquito breeding areas of the Florida Keys and may be attributed in part to the large quantity of leaf mold present in the vicinity. Here, *thelcter* occurred in association with *Psorophora johnstonii* (Grabham), *Psorophora ferox* (Humbolt), *Deinocerites cancer* Theobald, *Aedes tortilis* Theobald and an undetermined species of *Aedes*. Subsequent collections of mosquitoes from the pool revealed the presence of *Aedes atlanticus* Dyar and Knab, *Aedes taeniorhynchus* (Wiedemann), *Aedes sollicitans* (Walker), *Psorophora confinnis* (Lynch-Arribalzaga) and *Psorophora howardii* (Coquillett).

From December 5 to December 29, 1947, a total of 137 larvae and three pupae were collected from the Long Key pool from which seventeen males and ten females were reared. Two females were taken in biting collections. During the same period seventeen larvae were collected at Rock Harbor (Key Largo), Monroe County, from two temporary rain pools adjacent to larger permanent pot holes in the Conocarpus transition zone. The breeding sites compared favorably with that on Long Key with few exceptions, the pools being void of forest-floor vegetation and the surrounding trees providing an absolute shade. Numerous col-

[1] A contribution of the U. S. Public Health Service and the Florida State Board of Health, Jacksonville, Florida.

[2] Entomologist, Cal. State Dept. Publ. Hlth.
[3] Entomologist, U. S. Public Health Service.
[4] Director and Chief Entomologist, Division of Entomology, Florida State Board of Health.

lections of larvae and adult mosquitoes have been made during the period January to June, 1948, without further evidence of *thelcter* breeding on Long Key or at Rock Harbor.

Reared males and females with associated larval and pupal skins were submitted to Dr. Alan Stone, U. S. National Museum, who confirmed the determination of *A. thelcter* Dyar after comparison with available specimens of *thelcter* from Texas and *Aedes keyensis* Buren (1947) from Florida. Appreciation is also expressed to Dr. Harry D. Pratt for the loan of larvae and adult females of Texas *thelcter* from the collection of the Communicable Disease Center, U. S. Public Health Service, and for his opinion regarding the determination of *thelcter* and the taxonomic validity of *keyensis,* and to S. A. Sanitarian (R) D. C. Thurman, Jr., U. S. Public Health Service, Communicable Disease Center Activities, for helpful guidance in all phases of the study.

It is the belief of Dr. Stone, Dr. Pratt, Mr. Thurman and the authors that *A. thelcter* Dyar and *A. keyensis* Buren are synonymous. Thus, the initial collection record for *thelcter* in Florida is that of two females taken in a light trap at Key West, Monroe County, October 14, 1946 (Fernandez), as reported by Buren (1947).*

The distribution now is known to include the Lower Keys, described by Cooke (1945) as a narrow chain of islands formed from Miami öolitic limestone stretching from Bahia Honda to Key West.

Literature Cited

ANON. 1944. The Mosquitoes of Texas, Texas State Health Department. Austin, Texas. 100 pp.

BUREN, WILLIAM F. 1947. A New *Aedes* from the Florida Keys, *Proc. Ent. Soc. Wash.,* Vol. 49, No. 8, pp. 228–229.

COOKE, C. WYTHE. 1945. Geology of Florida, *Fla. Geol. Surv. Bull. No. 29.* 339 pp.

DYAR, HARRISON G. 1928. The Mosquitoes of the Americas, *Carnegie Institution of Wash. Pub. No. 337.* 616 pp.

MATHESON, ROBERT. 1944. Handbook of the Mosquitoes of North America, Comstock Pub. Co., Inc., Ithaca, N. Y. 313 pp.

* Twelve additional light trap records of *thelcter* from Marathon and Key West (recorded by Buren as *keyensis*) are in the unpublished records of the U. S. Public Health Service, Quarantine Station, for the months of June and July, 1947. Two collections of *thelcter* from Vaca Key in June and October, 1947, were made in light traps operated by the Florida State Board of Health.

NOTES ON MOSQUITO COLLECTIONS IN PENNSYLVANIA AND CANADA DURING 1948

STANLEY J. CARPENTER [1]

While observing the effect of aerial spraying of DDT for Gypsy Moth control in forest areas near Wilkes Barre, Pennsylvania, during May, 1948, the writer obtained the following new records of mosquitoes for Pennsylvania:

[1] Lt. Colonel, MSC, United States Army Caribbean, Fort Clayton, Canal Zone.

Aedes (Ochlerotatus) communis (De Geer)—May 6, a collection consisting of 25 larvae from a deep woodland pool in a coniferous forest in Bear Creek Township, Luzerne County.

Aedes (Ochlerotatus) implacabilis (Walker)—May 4, a collection consisting of 13 larvae from a temporary pool in an

open woodland in Madison Township, Lackawanna County.

Aedes (Ochlerotatus) excrucians (Walker)—May 4, 1 larva associated with *A. implacabilis* in the above collection; and 2 larvae from a temporary pool in a woodland in Tolyhanna Township, Luzerne County. May 6, 8 larvae from a temporary pool in a meadow in Lehigh Township, Lackawanna County; and 20 larvae from temporary pools in a coniferous forest in Bear Creek Township, Luzerne County. A tentative identification of this species in Pennsylvania (based on 4 female specimens) was made by Wilson *et al.*, (1946).

While vacationing in Canada, a collection consisting of 26 larvae of *Aedes (Finlaya) atropalpus* (Coquillett) was obtained by the writer from rock holes along the Chaadiere River at Beauceville, Quebec on July 15, 1948. This species had not previously been reported from Quebec Province.

Literature Cited

Wilson, C. A., Ralph C. Barnes and Herman Fellton. 1946. A List of the Mosquitoes of Pennsylvania with Notes on Their Distribution and Abundance. *Mosquito News*, 6(2):78–84.

EXTENSION OF KNOWN RANGE OF *AEDES ATROPALPUS* (COQUILLETT) SOUTHEASTWARD INTO GEORGIA [1]

B. Dolores Stough, Mary Ann King, and Don E. Eyles

Despite extensive collections by the Army and U. S. Public Health Service in the Southeastern United States during the recent war, *Aedes atropalpus* (Coquillett) was not listed from the state of Georgia and is known only in adjacent states from Tennessee and North Carolina (Carpenter, Middlekauff and Chamberlain, 1946).

We here report an extension of range southeast to middle Georgia. Larvae of this species were collected from pot-holes in the incomplete concrete foundations of an unfinished power dam at Furman Shoals on the Oconee River in Baldwin County on March 21, 1948. Whether or not the species was present in natural rock holes in the shoals was not determined but seems probable.

From a collection of about 40 living larvae an insectary colony was established. Females of this colony deposit fertile eggs without blood meals as has been described by other authors (Howard, Dyar and Knab, 1912; Trembley, 1947). We have found the species very easy to rear and specimens from the colony have been deposited in the U. S. National Museum, the collection of the Communicable Disease Center of the U. S. Public Health Service, the collection of L. E. Rozeboom, and other collections.

[1] Contribution from the Division of Tropical Diseases, National Institute of Health, United States Public Health Service, Milledgeville, Georgia.

References

Carpenter, S. J., Middlekauff, W. W. and Chamberlain, R. W. 1946. The mosquitoes of the Southern United States east of Oklahoma and Texas. American Midland Naturalist, Monograph No. 3, University Press, Notre Dame, Ind.

Howard, L. O., Dyar, H. G. and Knab, F. 1912. The mosquitoes of North and Central America and the West Indies. Publ. Carnegie Inst. of Washington, Vol. 1.

Trembley, H. L. 1947. Biological characteristics of laboratory-reared *Aedes atropalpus*. *Jour. Econ. Ent.* 40:244–250.

AN ANALYSIS OF THE PUPAL CHAETOTAXY OF *ANOPHELES QUADRIMACULATUS* (SAY) [1]

GEORGE HENRY PENN AND SIDNEY A. COLEMAN
Department of Zoology, Tulane University of Louisiana, New Orleans

The normal range of variation of the chaetotaxy of pupae of one species of anopheline mosquito from a single population has not previously been known. This study shows that the chaetotaxy of *Anopheles quadrimaculatus* pupae varies considerably more than was realized when the original description of the pupa of this species was written by the senior author (1949).

The exuviae of one hundred pupae of *A. quadrimaculatus* obtained from a laboratory colony maintained by the Tulane Department of Tropical Medicine were dissected and mounted in Canada balsam for examination. The length in microns of seta *8* on segments II through VII (Table 2), and the number of branchings of the principal setae on segments II through VIII and on the paddle were recorded for each specimen.

The original description (*loc. cit.*) was based on wild-caught specimens from various localities in Louisiana and South Carolina. Because of the range of variation shown to exist by the present study a redescription in comparison with the previous one seems called for, and is presented below in simplified tabular form (Tables 1 and 2). The location of the setae is shown in Figure 1.

Number of teeth on lateral margins of paddles ranged from thirty-six to fifty-seven, with an overall average of fifty.

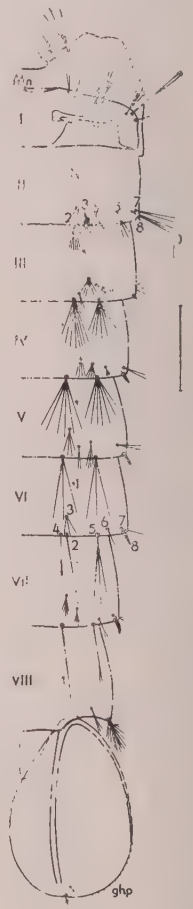


FIG. 1.—Right dorsal aspect of metanotum and abdomen of male *Anopheles quadrimaculatus* pupa. Vertical bar to right of specimen represents 0.5 mm.

Reference

PENN, GEORGE HENRY. 1949. Pupae of the Nearctic anopheline mosquitoes north of Mexico. *J. Nat. Mal. Soc.*, 8(1):50–69.

[1] One of a series of reports resulting from researches on *Mosquitoes and Other Aquatic Insects* supported by the University Council on Research of the Tulane University of Louisiana.

Table 1.—Number of branchings of the principal dorsal abdominal setae of *Anopheles quadrimaculatus* pupae.

Segment & seta numbers		Overall min.	Range max.	Majority range	Percent frequency	Range in Penn (1949)
II	2	5	12	5–8	80%	4–6
	5	2	6	3–4	81	3–4
	7	1	6	2–3	71	2–4
	10	1	6	3–5	82	2–5
III	2	5	15	7–12	87	7–9
	5	6	16	9–12	74	7–11
	7	2	7	3–5	80	2–4
IV	2	5	12	5–9	91	6–8
	5	4	11	6–10	90	7–8
	7	2	4	2–3	96	2–3
V	2	2	7	3–5	89	1–3
	5	3	6	4–5	73	2–3
	7	1	3	2–3	95	2–3
VI	2	1	3	2–3	94	1
	5	2	6	3–4	85	1–3
	7	1	2	2	69	1–2
VII	2	1	2	1	69	1
	5	2	5	2–4	97	1–3
	7	1	4	1–2	93	1–2
VIII	5	1	3	1–3	100	3–4
	8	10	19	13–16	68	10–16
Paddle	7	1	4	2	68	1–3
	8	1	4	1–2	73	1–2

Table 2.—Length in microns of seta 8 of *Anopheles quadrimaculatus* pupae.

Segment Number	Overall min.	Range max.	Average	Percent increase	Percent increase in Penn (1949)[2]
II	12	24	14	...	...
III	36	60	43	207%	146%
IV	60	84	65	51	62
V	60	84	75	15	13
VI	72	108	87	17	9
VII	72	108	96	9	7

[2] These figures were the basis of statements made in the reference, although the figures themselves were not published.

AN IMPROVED INSECT COLLECTING CAGE

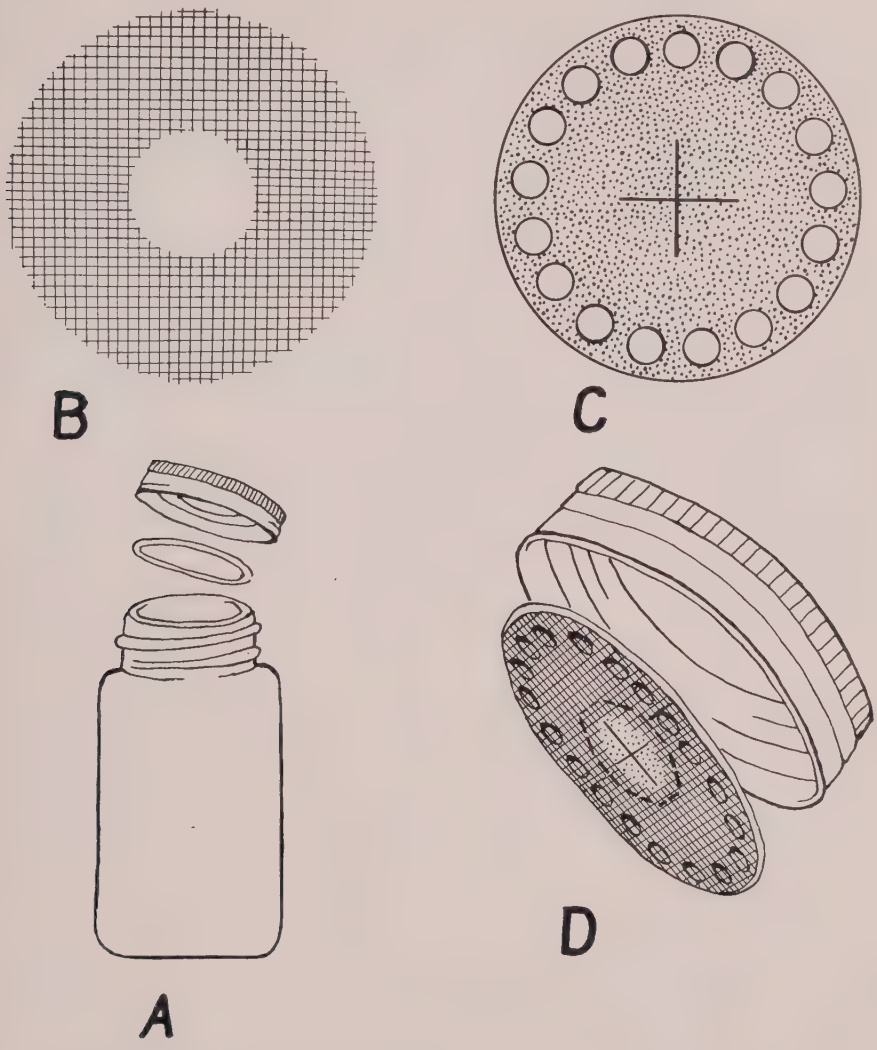
PAUL C. BEAVER AND ORLIN K. FLETCHER, JR.

The insect collecting cage described below was evolved to fulfill the requirement for a simple, easily constructed apparatus to facilitate the preservation of anopheline mosquitoes in the field. It is, however, readily adaptable for the collection of insects other than mosquitoes. In comparison with the well known lamp-chimney type of collecting cage the improved design has the advantages of greater strength and durability, simplicity of construction, and of being constructed of readily procurable materials.

The main body of the cage is composed of an ordinary screw-cap glass jar which may be varied in size from one-half pint to one gallon to suit the individual needs of the user. The particular type of jar used is equipped with a cap of two piece construction, composed of an outer band or ring which screws onto the neck of the jar and retains a center insert or seal. This center insert or seal is discarded and replaced with the door or baffle through which the insects are introduced into the cage by means of an aspirator or collecting tube. The door or baffle to the cage is formed from a disc of heavy sheet rubber (automobile inner-tube is excellent material for the purpose) and a disc of screen wire (16 or 18 meshes to the inch) as illustrated in figure 1. Since the disc fits over the mouth of the jar to close the opening, it should be of the same diameter as the insert which was removed from the cap. A circular opening, one inch in diameter, is cut from the center of the screen wire disc to permit passage of the aspirator or collecting tube. Two slits one inch long, bisecting each other at right angles, are cut in the center of the rubber disc and a series of small holes, about one-fourth inch in diameter, are punched one-fourth inch from the edge. The rubber disc is then superimposed upon the screen wire disc, and the two are stapled together with a paper-stapler. Or, if desired, the rubber disc may be vulcanized to the wire one. The slits in the rubber disc should be directly over the center opening which was cut in the screen wire and form flaps which effectively close the opening yet permit the introduction of insects. The small holes which were punched along the outer edge of the rubber disc serve as exhaust openings when the insects are blown into the cage from an aspirator, and also provide for ventilation. To complete the cage, the finished door or baffle is placed inside of the screw band (from which the insert has previously been removed) and the assembly screwed onto the mouth of the jar. The baffle-cap assembly is the fundamental part of the cage, and, since all common type fruit-jars, regardless of capacity, have openings of identical size, the baffle may be readily transferred from a small to a large jar, or vice versa, to suit the requirements of the moment. To clean or empty the cage it is necessary only to unscrew and remove the cap.

MOSQUITO CONTROL INSPECTION TOUR

SEE PAGE 181



LEGEND

FIG. 1.—Component parts of the insect collecting cage. A. Fruit jar with two-piece screw cap consisting of seal disc and retaining band. B. Screen wire disc having diameter equal to that of seal disc and with one-inch hole cut in center. C. Sheet rubber disc having diameter equal to that of seal disc, and with one-inch slits at center and quarter-inch holes punched around its edge. D. Finished door or baffle consisting of the original retaining band and units "B" and "C" stapled together.

NEWS AND NOTES

CALVIN CHAPPEL KIKER

CALVIN C. KIKER, principal malaria control engineer of the Tennessee Valley Authority, died on October 4 at his home in Sheffield, Alabama, of an acute heart attack.

Mr. Kiker was born in Blum, Texas, on August 24, 1897, and received his academic training in engineering at Texas Christian University. He started his professional career at Morris, Texas, in the position of highway engineer and later was named city engineer at Mineral Wells, Texas.

Mr. Kiker's reputation in the field of malaria engineering was established during his service with the Alabama State Health Department which covered the period 1923–1934. He joined the staff of the Tennessee Valley Authority as associate sanitary engineer assigned to the Malaria Control Branch on November 1, 1934. The history of his activities in the malaria field during the fifteen years, from 1934 to the present, and his contributions to the suppression of the disease in the Tennessee Valley are well known to those interested in the control of malaria. Those who have been privileged to work with Mr. Kiker have profited greatly through his sound judgment and common sense and his knowledge of malaria control gained through conscientious hard work. Mr. Kiker was an exceptional person. From his early days with the Alabama State Board of Health he showed a fertile imagination and was indefatigable in the pursuit of his chosen profession. His work was productive of important results as is evidenced by the substantial contributions which he has made to the literature on malaria control. He was a member of the American Public Health Association, the American Mosquito Control Association, and the National Malaria Society.

THE NATIONAL MALARIA SOCIETY held its 32nd Annual Meeting conjointly with the American Society of Tropical Medicine and the American Academy of Tropical Medicine, November 6–9 at Memphis, Tennessee. AMCA members figured prominently in the proceedings. The list of officers elected follows:

Paul F. Russell, *President*
Justin M. Andrews, *President-Elect*
W. H. W. Komp, *Vice President*
Martin D. Young, *Sec.-Treas.*

Fred L. Soper, another AMCA member, received the George Washington University Theobald Smith Gold Medal in recognition of his work in Brazil.

With so many of our fine members at the helm, the National Malaria Society will have a banner year. To Dr. Russell, one of our most faithful, we wish the best of luck, sincere hopes for the future, and promise our cooperation in every possible manner. H. L. T.

FROM DON M. REES: "The annual meetings of the U.M.A.A. will be held in Ogden, Utah, on Friday and Saturday, the 17th and 18th of February, 1950. I thought you might be interested and if you have any information about any of the mosquito control workers from the East who are planning to attend the California or Utah meetings I would appreciate it if you would send me their names, and I will invite them to participate in our program." D. M. R.

NEW JOURNAL OF TROPICAL MEDICINE. A new quarterly journal of tropical medicine and hygiene entitled "Documenta Neerlandica et Indonesica de Morbis Tropicis" has recently appeared. It is entirely in English, although published in Amsterdam. (Rivierenloan 268, subscription price $4.50 per annum.)

The editorial board is staffed by a group of widely known scientists under the chairmanship of Prof. N. H. Swellengrebel. The journal is well printed on good paper and the numerous illustrations are excellent. The articles in the first two numbers cover a wide range of subjects including scrub typhus, malaria and some entomology. F. C. B.

HIGH SCHOOL STUDENTS ATTEND CLASS ON MOSQUITO CONTROL

THE BIOLOGY CLASS OF THE NORVIEW HIGH SCHOOL met at the field office of the Norfolk City Mosquito Control Commission, on October 6 to study the habit of mosquitoes. Perry W. Ruth, Secretary and Technical Advisor of the commission. addressed the class and let them view the various species of mosquitoes through the microscope as well as going into the habits of the mosquito and explaining to them the difference of the flight range of each mosquito as well as the mosquitoes that bite and the ones that do not.

One of the things that interested the group was being shown how to tell a female mosquito from a male. After they were shown how easy it is, one remarked, "Oh, me. How easy after you know how." "Skeeter," Oct. 1949.

ROSTER OF SANITARY AND PUBLIC HEALTH ENGINEERS. The American Public Health Association, in cooperation with the National Security Resources Board, is preparing a roster of sanitary and public health engineer citizens of the United States. This roster, to a great extent, will supplement and bring up to date the roster prepared by the War Manpower Commission. Its uses will be manifold, but the immediate interest of the National Security Resources Board in such a roster is to provide a means by which trained sanitary and public health engineers can be assured of proper utilization of their professional training

should another national emergency arise. The Engineering Section Project of the American Public Health Association is directly responsible for the collection of data and preparation of the roster, and has been distributing questionnaires to be used in gathering the basic information.

It is recognized that no single source of information is available for the preparation of the master mailing list. Many engineers are not registered with state boards of registration. Likewise, many are not members of national engineering organizations. As a result, it is likely that many qualified engineers will not receive the questionnaire. It is important for each sanitary or public health engineer to act for himself in the matter. Any engineer who does not receive a copy of the questionnaire within the next two or three months should notify the Engineering Section Project, American Public Health Association, 1790 Broadway, New York, so that his name can be entered in the master file and a questionnaire sent to him. In this way his name can be included in the roster.

Since the basic data collected in the preparation of the roster will remain the property of the American Public Health Association, it is planned to make certain basic information available to engineering societies and organizations cooperating in the preparation of the roster. . . . From a News Release of the American Public Health Association, 1790 Broadway, New York, N. Y.

COLONEL AFRIDI TO WHO. Readers of Mosquito News will be pleased to know that Colonel M. K. Afridi, C.B.E., M.D., Ch.B., D.T.M.&H., has been made Deputy Director, World Health Organization Regional Office for Eastern Mediterranean Region, Box 1517, Alexandria, Egypt. Colonel Afridi formerly Director of the Malaria Institute of Pakistan and Bureau of Laboratories is a leading authority on malaria and is well known to those dealing with mosquito problems in this country. Congratulations, Colonel Afridi, and best wishes in your new and important undertaking. F. C. B.

C. Y. CHOW, who has been keeping in touch with the AMCA, wrote recently: "This fall term I was offered a full professorship in Taiwan University to teach medical entomology. At the same time, I am Consultant to the Taiwan Malaria Institute. Please put my address in your 'News.' "

Dr. Chow is now located at the Department of Zoology, National Taiwan University, Taipeh, Taiwan, China.—H. L. T.

FURTHER NOTES ON JUNGLE YELLOW FEVER IN PANAMA. A most interesting note on the recent outbreak of yellow fever in Panama was presented by Mr. W. H. W. Komp. Mr. Komp said that six cases had died in the local Government hospital without being diagnosed. All were cases of true jungle yellow fever, as they occurred in adult men who had been in close contact with forests. The presumed mosquito vector is one or more of the four common species of the genus *Haemagogus* which are found on the Pacific side of the Isthmus. No cases of yellow fever developed in the city of Panama or in the Canal Zone, as spraying of DDT for control of *Anopheles* had practically eliminated the urban vector of yellow fever, *Aedes aegypti*. . . . From Minutes of 590th Regular Meeting of the Entomological Society of Washington (D. C.), April 7, 1949.

H. L. T.

WHERE BUT IN JERSEY? When the Macmillan Company, publishers at 60 Fifth Avenue, published "The Natural History of Mosquitoes" recently, they looked around for some technical journals in which to advertise it. One, they said yesterday, was most appropriate.—"The Mosquito News," a New Jersey publication issued, not for the insects, but for their exterminators. . . . N. Y. Herald Tribune.

EDITORIAL

An editorial may be a bore or it may be stimulating. If an editor likes to pontificate he can always find an excuse for filling up space. But if he does not like to pontificate; if he is not an authority on anything or has already talked himself out on the subjects in which he or others feel that he can speak authoritatively; if the advice and profound observations he might otherwise give have already been expressed better by someone else; and if he cannot dig up or think up anything of timely interest, then he ought to let someone else do the talking. Your present editor often finds himself in one of these positions—which one, he will not say.

In the present instance, and even if the editor did not find himself in one of those positions, the editorial page could not be put to better use than to call special attention to the paper by Dr. F. C. Bishopp, appearing in this issue, on insecticides for mosquito control.

This paper should be required reading not only for every mosquito control worker but also for every public health official. A reading of the paper will make further editorial comment superfluous.

ASSOCIATION NEWS

MAKE YOUR PLANS NOW

To attend the meetings of the AMCA with the VMCA at the Cavalier Hotel, Virginia Beach, February 22, 23, 24, and on March 1, 2, 3, The New Jersey Mosquito Control Association at Atlantic City at Haddon Hall

Perry W. Ruth, Chairman of the Program Committee, and R. E. Dorer, Chairman of the Arrangements Committee, have sent in to the NEWS some very interesting and attractive preliminary information, as the following quotation will attest:

"For your information we have sent invitations to forty-seven foreign countries and have replies from: Prof. Dr. Amador Neghme-Rodriguez, Santiago, Chile; Dr. H. P. S. Gillette, Trinidad, B.W.I.; Dr. E. J. Pampana, Geneva, Switzerland; Prof. Gregory Liwadas, Athens, Greece; Paulo C. A. Antunes, Sao Paulo, Brazil, who is now working with the Pan American Sanitary Bureau in Washington, D. C., while on temporary leave from his work in Sao Paulo; Dr. Gordon Covell, Surrey, England; Dr. Mehmed Aziz, Nicosia, Cyprus; Dr. L. J. Bruce-Chwatt, Nigeria, British West Africa; Dr. D. H. S. Annecke, Tzaneen, Northern Transvaal,

South Africa; Dr. A. A. Kingscote, Guelph, Canada; Dr. Charles G. Dobrovolny, Guatemala; Dr. Wilbur G. Downs, Mexico; Dr. Augusto Leopoldo Ayroza Galvao, Sao Paulo, Brazil, who is on temporary leave from his country while now taking a course in the School of Public Health at Columbia University; Dr. Herbert C. Clark, Panama; Dr. C. R. Twinn, Ottawa, Ontario; Dr. J. Farias, Tampico, Mexico; Dr. Arnoldo Gabaldon, Venezuela, and Professor H. Galliard, Paris, France.

"The Program Committee has met and decided on a tentative program; however, it will be some time before the speakers and their subjects will be confirmed. In general the program will be divided as follows: The opening session on February 23 will be donated to the Virginia Mosquito Control Association. The afternoon session will deal with the role of Federal agencies in controlling mosquitoes and malaria. The evening session will lead off with the installation of the incoming president, and will follow with a panel discussion on 'Today's Problems in Controlling Mosquitoes and Latest Recommended Insecticides.' The morning session of February 24 will deal with 'Methods and Practices for Mosquito Control' and will also include 'Mosquito Eradication Programs Around the World.' The afternoon session will deal with miscellaneous subjects and the final session will conclude with a banquet."—Perry W. Ruth.

Mr. Dorer has sent or will send on request, to members a schedule of the meetings and the tours that will precede or follow them. This schedule will be substantially as follows:

Tuesday, February 21—Inspection trip of activities in and about Washington, D. C., and Beltsville Experimental Station of the U. S. Department of Agriculture. The inspection trip will start at the Department of Agriculture Building Bureau of Entomology, at 9:00 a.m. Those wishing to attend this portion of the trip should get in touch with the chairman of the arrangements committee for Monday night accommodations.

Wednesday, February 22—Leave Department of Agriculture Building at 9:00 a.m. Travel to Virginia Beach stopping to see historical points of interest en route. Hospitality hour at the Cavalier Hotel, 6:00 to 7:00 p.m. Distance about 225 miles.

Thursday, February 23—Joint meetings of the American Mosquito Control Association and the Virginia Mosquito Control Association featured by a symposium lead by Dr. F. C. Bishopp on use of new insecticides for controlling mosquitoes and participated in by mosquito control workers from all over this country and other countries. Sessions to be held in the Cavalier Hotel, 9:30 a.m., 2:00 p.m., and 8:00 p.m.

Friday, February 24—Joint meetings of the American Mosquito Control Association and the Virginia Mosquito Control Association concluding with a banquet featuring several prominent speakers. Sessions to be held in the Cavalier Hotel, 9:00 a.m., 2:00 p.m., and 7:30 p.m.

Saturday, February 25—Expedition leaving Cavalier Hotel at 9:00 a.m.; inspecting mosquito control work and equipment at Virginia Beach, Norfolk, Elizabeth City County, Warwick County, and Williamsburg; finishing up at Williamsburg to spend the night at the Williamsburg Lodge. Also, viewing the historic shrines in this section of the Commonwealth. Distance 75 miles.

Sunday, February 26—Leave Williamsburg Lodge at 9:30 a.m.; visiting several places of historic interest en route to Wicomico Hotel, Salisbury, Maryland. Distance 300 miles.

Monday, February 27—Leave Wicomico Hotel, Salisbury, at 9:00 a.m.; inspecting mosquito control operations and equipment in Delaware; finishing up that evening at the Hotel DuPont, Wilmington, Delaware. Visit headquarters at Lewes, Delaware, including shop, DDT mixing

plant, cleaning machines, and viewing marshes from ground which are controlled by airplane spraying. Distance 200 miles.

Tuesday, February 28—Leave Hotel DuPont, Wilmington, Delaware, at 9:00 a.m.; inspecting mosquito control work and equipment in South Jersey; finishing up at Atlantic City, New Jersey. Open and diked salt marshes will be viewed, several types of salt marsh ditching equipment will be demonstrated, an opportunity will be afforded to see the oyster fleet and inspect an oyster packing plant, further opportunity will be had to note salt hay production, and several points of historic interest will be viewed. Distance 150 miles.

Wednesday, Thursday, Friday—March 1, 2, and 3—Attend New Jersey Mosquito Extermination Association meetings at Atlantic City. This will be the thirty-sixth annual meeting of the Association. It is the oldest and, perhaps, the most widely known of any similar one in the world.

Saturday, Sunday—March 4 and 5—Special inspection trip of mosquito control operations in North Jersey and Long Island will be arranged for those wishing to visit these localities. This would include inspection of mosquito methods and equipment used in heavily populated urban areas.

Accommodations at strategic points along the route of the expedition are being arranged by the committee, but it will be necessary for you to inform Mr. Dorer if you plan to take advantage of them. Apply to him for the general information sheet, questionnaire and prospectus of the expedition. Then fill out the questionnaire and return it to him.

Get this information whether *you plan to go* or *not. It will convince you that you must go.*

Mr. Dorer's address: Rowland E. Dorer, Chairman Arrangements Committee, Room 204, Essex Building, Norfolk, Virginia.

REVIEWS AND ABSTRACTS

Malaria. The Biography of a Killer. By Leon J. Warshaw, M.D. 348 pp. Cloth. Price, $3.75. Published in November, 1949. Rinehart & Company, Inc., New York and Toronto. A New York City cardiologist, finding himself unable to answer a patient's questions about malaria, consulted the libraries of the Academy of Medicine and of the Surgeon General. He became so interested that he continued to delve into malaria literature for a period of some two and a half years. Then another patient, a book publisher, encouraged the preparation of a manuscript and this has become the book under review—an excellent informal sketch of malariology which should prove attractive not only to laymen but to physicians and also to those specializing in any branch of the subject. The author's style is clear and effective and his account, with a few exceptions, is accurate and well founded. There are no illustrations, but there is a short bibliography and a brief index. The book is well edited, printed, and bound.

The author traces some of the known or presumed effects of malaria on the course of history, from the fatal attack suffered by Alexander the Great in 323 B. C. to the control of malaria in the South Pacific Theater in World War II (under the exceptionally capable direction of Captain J. J. Sapero, USN, who commanded and integrated both Army and Navy units and whose name might well have been mentioned).

The Laveran, Manson, Ross, Grassi, Watson, and Gorgas stories are all included and there are several chapters dealing with cinchona, quinine, and the newer synthetic drugs. *Gambiae* eradication from Brazil is described (but not the similar project in Egypt) and there are brief accounts of DDT, repellents, nets and other malaria control agents. Finally, there are short chapters on therapeutic malaria and on "Unsolved Problems."

Dr. Warshaw has obviously given painstaking care to a study of his references and he has produced a very good book. But an author not actively acquainted with his subject may sometimes be misled by the literature and this no doubt accounts for the totally erroneous picture on page 6 of the present status of malaria in the United States. The author estimates "that throughout the country there is an average of 4,000,000 cases every year." As a matter of fact, it is doubtful if there were 4,000 indigenous cases of malaria in all the continental U.S.A. in either 1948 or 1949. The situation has changed dramatically in the past 25 years and the author might well have given much attention to this aspect of the malaria story. There is scarcely any mention of the outstanding malaria control work of the USPHS, in cooperation with state and county health departments, now culminating in the drive of the Communicable Disease Center which aims to eradicate malaria within the next few years as an endemic disease in the U.S.A.

Also neglected are the current vector eradication projects in Cyprus, Sardinia, and Mauritius and the outstanding national malaria control programs of Venezuela and Italy. On page 5, the author refers to "almost universal infection with malaria" in the Roman Campagna, yet the fact is that malaria has been completely defeated in that area. Thanks to a program of the Allied Military Government in 1944–1945, UNRRA in 1946–1947, and of the Italian government in 1948 and 1949, malaria is now rare both in the Roman Campagna and the Pontine Marshes, classical homes of the "Marsh Dragon."

Minor criticism may be directed at the resurrection of Campbell's thoroughly discredited "bat hotel" (pp. 133–134), the interchangeable use of "larvacide" (p. 145) and "larvicide" (p. 299), "chloroguanide" for chlorguanide (p. 281); "metacrine" for mepacrine (p. 267), and the implication that DDT kills flies "instantly" (p. 161).

Incidentally, the author makes the interesting statement (p. 307) that during World War II the German High Command sent a "malariologist" to the Pontine Marsh area to give an opinion "as to how the flooding could be done with the least damage from the malaria standpoint." In the reviewer's opinion (based on experience and observation during active service in the area in 1944) the word should be "most," not "least."

These criticisms should not be given too much weight because the text as a whole is excellent and is remarkably free from mistakes. The reviewer heartily recommends this book as an unusually good account of the story of malaria—"how it has influenced man through the ages" and "how our present knowledge of it was acquired" (p. 327).—Paul F. Russell, Rockefeller Foundation, New York City.

Report on the Third Session, Expert Committee on Malaria, Held 10–17 August, Palais des Nations, Geneva. World Health Organization, United Nations. 47 pp. Processed, Aug. 19, 1949. Members of the Expert Committee on Malaria in attendance at this session were Afridi of Pakistan, Covell of the United Kingdom, Gabaldon of Venezuela, Russell of USA, Singh of India, Swellengrebel of Holland, Vaucel of France and Wilson of Tanganyika, with Pampana of WHO as secretary.

The report outlines the origin of this advisory committee to the WHO and the actions taken to date. It then deals briefly but forcefully with the problem of malaria in underdeveloped areas of the world, pointing out "while each year malaria in one area after another is retreating dramatically as a result of the effective use of such new insecticides as DDT, yet the disease still has high

incidence in large areas, causing hundreds of millions of cases and millions of deaths. Malaria still holds back, or makes impossible, food production in underdeveloped areas; it still interferes seriously with industrial and agricultural activities in much of the tropics and subtropics; and it still takes a high toll of victims in infancy and early childhood;" and continuing, "the committee in the reports on its first and second sessions stressed the fact that by virtue of insecticides developed since 1940 it is now possible to obtain a degree of malaria control, amounting in some cases to actual eradication, formerly unattainable. During the past year, numerous additional examples of the successful application of residual insecticides have abundantly confirmed this fact. But the great need for effective governmental antimalaria organizations and for overcoming the critical shortages of trained personnel, remains almost unchanged."

The situation with reference to antimalarial drugs is reviewed at length with an appraisal of the value of quinine, mepacrine, chloroquine and other 4—aminoquinolines, proguanil, pamaquin and other 8—aminoquinolines in the treatment and prophylaxis of malaria, with usual dosages. Procedures are advised for obtaining further accurate information on chemotherapeutical agents through field and hospital trials.

In response to an earlier recommendation by this committee an expert committee on insecticides was set up to deal with various insecticide problems.

The report under review gives attention to means of preventing the importation of *Anopheles* and deals at length with the relative merits of residual spraying and species eradication. It is difficult to understand why the committee should consider these as methods to be contrasted since in species eradication residual spraying would appear to be one of the most important procedures.

The cooperation of the United Nations International Children's Emergency Fund and the Food and Agriculture Organization in antimalarial work is recognized and suggestions on organizational and procedural plans are presented including the training of malaria teams and the choosing of fields of operation.

In its recommendations to governments the committee set forth an excellent and well-balanced program looking toward the accomplishment of one of the ultimate objectives of WHO—the eradication of malaria. In these recommendations it is stated that "while therapeutic and prophylactic antimalarial drugs should be available to those who require them (regardless of ability to pay for such treatment), it must be emphasized strongly that in numerous rural areas throughout the world the use of residual sprays has in two or three seasons made mass chemotherapy and mass chemoprophylaxis of malaria unnecessary and obsolete."

In its summary of recommendations emphasis is placed on residual spraying with insecticides, and larval control is referred to as follows: "The Committee recommends that larval control should be abandoned in rural areas where residual insecticides are found to be effective and are extensively applied." In the writer's opinion this is too strong a statement even though it may be generally true.

Despite the great emphasis put on the value of entomological measures in combating malaria it is noted that not a single entomologist has a place among the Expert Committee membership. It is the opinion of the writer that the committee has not stressed sufficiently the need for continued research on the development of additional cheap, safe and effective insecticidal materials and methods for obtaining maximum efficiency in their use. The need for intensifying entomological and chemical research in the field is emphasized by the fact that insects, including mosquitoes, tend to develop resistance to insecticides and we do not know when substitutes for a given malaria-control insecticide will be required.—F. C. Bishopp.

CONTRIBUTIONS TO THE KNOWLEDGE OF THE DANISH AND FENNOSCANDIAN MOSQUITOES. CULICINI SUPPL. I. By Lief B. Natvig. Norsk Entomologisk Tidsskrift, pp. 148, fig., 12 plates, 1 folding map. 1948. In English. Available from A. W. Brøggers Boktrykken A/S, Karl Johans gt. 12, Oslo, Norway. Price: Norway Kr. 50.00 (U. S. $10.00). This is an exceedingly comprehensive taxonomic and biological study of the culicine mosquito species of Denmark, Norway, Sweden, and Finland. Included within the volume are the following: A discussion of the morphology of all the stages of the mosquito, general notes on the life histories of the included species, a classification of the Culicini of northern Europe, a history of previous investigations, keys and descriptions of the species, the distribution (also shown on outline maps) and biology of each, and an important discussion of the zoogeography of the culicine species of northern Europe and Asia. Figures of the male genitalia and larva are included for each species. Extensive quotations from the literature are used throughout and all of the involved languages except German have been translated into English. This book will have much value and interest for the North American workers because of the Holarctic distribution of much of the included fauna. Of the 35 species treated, 19 are definitely known to occur within the Nearctic region.

The author brings to this very considerable task the experience of 18 years of field mosquito investigations in Norway. In addition he has had the opportunity of studying most of the principal mosquito collections of northern Europe.

As a compilation of the enormous literature and as a revision of existing collections, this book admirably serves as a basic foundation for the

detailed studies that are still so badly needed for most of the northern culicines. From the standpoint of the taxonomist it is to be regretted that larval-pupal skin associated adults were not prepared throughout the years of work since it is largely such material that will be needed for the problem of determining whether or not intraspecific populations and races occur. Also, the lack of such material made impossible the acquiring of much new data on the separation of the females of the very important aedine subgenus *Ochlerotatus*. However, the use of Peus' key to the females, with its employment of the pleural scale patches, in naming the material studied has resulted in a valuable confirmation of the value of these characters.

The author is to be congratulated for the accomplishment of such a difficult and important task.—Kenneth L. Knight, Naval Medical Research Institute, Bethesda 14, Maryland.

Additional comments from a review received later than that of Dr. Knight: . . . Of special interest is a chapter reviewing the accounts of explorers and others of their experiences with the very serious mosquito pest in the Far North.

The distribution of the species is given for other parts of the world as well as for Denmark and Fennoscandia. One list of the species recorded in Scandinavia indicates which of them also occur in Siberia and North America.

The monograph is profusely illustrated, most of the figures depicting points in the anatomy of larvae and adults of taxonomic significance. There are also a number of maps showing the distribution of many of the species, and several plates of photographs showing typical breeding places.

Dr. Natvig's book is an important and valuable contribution to a knowledge of the northern mosquitoes, and should be in the possession of all who are interested in the study of these serious pest insects. The author proposes shortly to take up work on a monograph on the Anophelini of the same region.—C. R. Twinn.

UN CASO DE ELIMINACIÓN LOCAL DE *Anopheles darlingi* POR OBRAS DE INGENIERÍA SANITARIA. By A. L. Berti. Jour. Inter-American Assoc. San. Eng. 2(2):103–110. 1948. In Spanish, with additional 3 page summary in English. In this engineering publication, it seems appropriate to describe how drain and fill methods were successfully applied to control *A. darlingi* within and around the twin towns of Acarigua-Araure (See Fig. 1, Page 104). In these towns, *A. darlingi* was the only malaria vector among the 15 anopheline species discovered, and the engineering methods mentioned above were the only control measures applied. It is the first example we know of local elimination of *A. darlingi* by such means.

In order to obtain some idea of the malaria picture in Acarigua before the project, communications dating from 1937 and sent by the original senior malaria inspector and the senior engineer were consulted. These records indicated there were 381 malaria cases within the town in 1939 when the project started. Table 1 (see page 105) lists breeding places existing in 1939, including those of *A. darlingi*. This table as well as Fig. 1 points to the ponds being the chief problem because of their numbers, extensiveness, the presence of *A. darlingi*, and cost of their elimination. Therefore, first steps were directed towards their drainage. The control project was initiated in 1939.

Since the population of Acarigua-Araure is 12,000 the per capita protective measures taken, broken down in terms of volume of the total work performed, were 12 cu. m. of excavation, 7 cu. m. of fill, and 2 lineal meters of lined ditch. Cost per capita was $5.52, higher than in any other town where malaria control has been accomplished by the same methods. The cheapest per capita cost was registered in Guama (Yaracuy). Other local costs range from $1.50 to $5.52. An area of 13,730 acres was drained at a cost of $661,000.00, or at an average figure of $48.90 per acre for eradication of *A. darlingi*.

The application of the species sanitation principle by which measures were mainly directed against the responsible mosquito *A. darlingi* permitted the preservation of the lakes El Veladero and Los Muertos, which have much importance for their wild life conservation, tourist and historical values. The Los Muertos pond was the Araure battle field during the War of Independence. Restriction of control measures to the vector species also permitted saving the expense of draining these ponds.

At Acarigua-Araure the only mosquito control measures applied were drainage, fill and scraping activities. Insecticides were never used. The results pointed to the efficiency of such a program in the permanent protection of localities. From Table 2 (see page 107) a striking comparison can be made between malaria indices before 1940 and those for 1947. Today Acarigua is a prosperous industrial center. The reclamation of 1,000 acres for agricultural and industrial developments is an added benefit. Instead of 2 or 3 saw-mills there are over 10 in operation today.

Applied engineering practices in malaria control pay for themselves in reducing the mortality rate, saving man-days lost due to disease, and above all, in increasing the value of land through drainage and fill operations, and roads, bridges, culverts and other structures built.—Excerpts from author's English summary.

COLONIZACION EN EL LABORATORIO, DE *Anopheles aztecus* HOFFMAN. By W. G. Downs, E. Bordas, and A. Arizmendi. Rev. del Inst. de Salub. y Enferm. Trop. 9(3): 2 pp. Sept. 1948. Mexico, D. F. In Spanish. This report is based on a colony of *Anopheles aztecus* Hoffman 1935, currently maintained in a laboratory in the vicinity of Xochimilco, Mexico. At least 11 generations have been raised since the colony was

started from eggs deposited by locally-caught females.

The larvae were reared in white enamelled pans, 18 x 40 cms. A thin layer of algae and water (not over 1 cm. deep) covered the bottom of the pans. Crushed dog food was fed twice daily; and the algae inhibited excessive fungus growths. The water in the pans was not changed during the larval period. Pupae were removed daily.

Adults were kept in screen-wire cages 90 cm. on a side (or 3 x 3 x 3 feet). They had constant access to sugar or honey solutions, and were offered a blood-meal daily. At first, only human blood was acceptable, but later, guinea pigs could be used if the surface for feeding were first shaved and moistened. For oviposition, the adults preferred open water to wet filter paper.

The temperature range was 22° to 26° C. (approximately 70° to 80° F.) and relative humidity 75% to 95%. The entire life-cycle required 29 to 30 days—egg stage, 3 to 4 days; larvae, 17 to 18 days; pupae, 2 to 3 days; and preoviposition, 5 days.—H. L. T.

AN EPIDEMIC OF MALARIA IN THE KENYA HIGHLANDS TRANSMITTED BY *Anopheles funestus*. By R. B. Heisch and J. O. Harper. Journ. Trop. Med. and Hyg. 52(9):187–190. 1949. (1) An epidemic of malaria is described which occurred in the Kericho District of Kenya Colony, and was thought to have been transmitted by *A. funestus*. (2) During the epidemic *A. funestus* was the predominant anopheline with an infectivity rate of 2.5 per cent. A few *A. gambiae* were also taken but all were negative for sporozoites. (3) the parasite rate of 300 natives examined in May towards the end of the epidemic was 36 per cent; by August it had dropped to 19.5 per cent. The predominent parasite was *P. falciparum* and only a few infections with *P. malariae* and *vivax* were seen. The crescent rate after the epidemic was 3.6 per cent which is low for an epidemic area. —Authors' summary.

THE ANOPHELINE MOSQUITOES OF TAIWAN (FORMOSA), CHINA. By C. Y. Chow. Quarterly Journal of the Taiwan Museum. Vol. II (1):1–8. 1949. Topographical variation of Taiwan, an island of 35,961 sq. km. of which 57.6% is lowland; 21.4% hilly; and 21% mountainous, supply habitats for sixteen species of *Anopheles*. Distribution of the species is summarized by "Hsien" (Prefectures). Identification keys to both adult females and larvae are presented with notes on the morphological variations and biology of each species. *A. hyrcanus sinensis* Wied, 1828 is considered to be the most predominant species of the island and is probably the chief vector of malaria in the plains, while *A. minimus* Theob., 1901 is probably the chief malaria vector in the hilly regions. The author has prepared an informative paper in an interesting and concise style.—Ernestine B. Thurman, Bureau of Vector Control, Berkeley, California.

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO CONTROL WORKERS AND MALARIOLOGISTS

H. H. STAGE AND HELEN SOLLERS

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

ANONYMOUS. 1948. Over 1¼ million dollars expended in mosquito control work. Calif. Health 6(8):63.

ABDEL-MALEK, A. 1949. A study of the morphology of the immature stages of *Aedes trivittatus* (Coquillett). Ent. Soc. Amer. Ann. 42(1):19–37.

AMERICANO FREIRE S., AND FARIA, G. S. 1947. Rearing and some data on the biology of *A. darlingi*. Rev. Brasileira Biol. [Rio de Janeiro] 7(1):57–66, 11 refs.

APARICO GARRIDO J., AND BENITEZ CALVO, L. A. 1949. La cloroquina en la tratamiento de paludismo: accion del medicamento sobre la sintomatologia y la parasitemia. Med. Colon. [Madrid] 13(2): 66–82.

ARCHILA, R. 1948. Historia del paludismo en la Antiqua Provincia de Apure. Rev. Sanid. y Asistencia Soc. 13(3/4):185–301, 21 refs.

ASQUITH, R. S., HAMMICK, D. L., AND WILLIAMS, P. L. 1948. The conversion of mecaprine and similar derivatives of 5-aminoacridines into thioacridones by the action of hydrogen sulphide. [London] Chem. Soc. Jour. Aug.:1181–1183.

BACIGALUPO, J. 1948. Ah invisible stage of *Plasmodium gallinaceum*. Semana Med. 55(49): 1151–1154.

———— 1948. Plasma virulento en paludismo aviaro. Soc. Argentina Biol. Rev. 24(3):212–217.

BALL, E. G., AND COWORKERS. 1948. Studies on malarial parasites. IX. Chemical and metabolic changes during growth and multiplication in vivo and in vitro. Jour. Biol. Chem. 175(2):547–571. 23 refs.

BAMI, H. L., AND COWORKERS. 1949. Preliminary antimalarial screening tests of some biguanide derivatives. Current Sci. [India] 18(2):50–52.

BAMI, H. L., IYER, B. H., AND GUHA, P. C. 1947. Studies in antimalarials. Parts IV and V. Indian Inst. Sci. Jour. 29A(3):9–14; 15–22.

———— 1948. Studies in antimalarials. Parts VI, VII, and VIII. Indian Inst. Sci. Jour. 30A (1):1–7; (2)9–13; (3):15–26.

BARNARD, C. I. 1949. The Rockefeller Foundation—A review for 1948. The Rockefeller Foundation. 71 pp. New York.

BENNISON, B. E., AND COATNEY, G. R. 1948. The sex of the host as a factor in *Plasmodium gallinaceum* infections in young chicks. Science 107(2771):147–148.

BERBERIAN, D. A., AND DENNIS, E. W. 1949. The effect of chloroquine diphosphate on malaria splenomegaly. Amer. Jour. Trop. Med. 29(4): 463–471, 11 refs.

BERTHOLF, J. H. 1949. Report of Broward County Anti-Mosquito District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 46–50.

———— 1949. Sandfly control program of the Broward County Anti-Mosquito District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 51–53.

BERTI, A. L., AND MONTESINOS, M. 1946. Rice-growing in connection with malaria: The problem in Venezuela. Cuad. Verde Com. Ejecut. 3a Conf. Interamer. Agr. (Caracas) No. 52, 33 pp., 10 refs.

BETTINI, S. 1948. Su alcuni casi di malaria trattati con il paludrine. Rendic. 1st. Sup. San. [Roma] 11(4):816–820. Also in Riv. de Parassitol. 9(2)107–111.

BICK, G. H. 1949. Distribution and larval ecology of the mosquitoes of New Guinea. Cornell Univ. Abs. Doctors' Theses 1947, pp. 248–250.

———— 1949. Notes on mosquitoes from Leyte, Philippine Islands (Diptera, Culicidae). Nat. Hist. Misc. No. 41, 7 pp., 8 refs.

BLACK, R. H. 1949. Observations on the treatment of *falciparum* malaria. Roy. Soc. Trop. Med. and Hyg. Trans. 42(6):565–568, 13 refs.

BLIVEN, B. 1949. Conquering the worst of all diseases. New Republic 120(11):17–19.

BOTT, R. 1948. Stechmucken-eir. Natur. u. Volk 78(10/12):142–146, 2 refs.

BRADLEY, G. H., AND LYMAN, F. E. 1949. Mosquito control activities of the Communicable Disease Center. U. S. Public Health Service. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting. pp. 22–25, 2 refs.

BRELAND, O. P. 1949. Distinctive features of the larvae of *Aedes alleni* Turner (Diptera: Culicidae). N. Y. Ent. Soc. Jour. 57(2):93–100.

———— 1949. The biology and the immature stages of the mosquito, *Megarhinus septentrionalis* Dyar & Knab. Ent. Soc. Amer. Ann. 42(1):38–47.

BRISOU, J., CASTET, A., AND AUTHEMAN, R. 1948. Experimentation d'un nouveau produit antilarvaire. Soc. de Path. Exot. Bul. 41(7/8): 485–487.

BRUETSCH, W. L. 1949. Why malaria cures general paralysis. Indiana Med. Assoc. Jour. 42 (3):211–216.

BUGHER, J. C., AND TAYLOR, M. 1949. Radiophosphorus and radiostrontium in mosquitoes. Preliminary Report. Science 110(2849):146–147.

BUONOMINI, G., SICCA, G. T., AND MANFREDI, M. 1948. Malaria in the Island of Elba. Riv. Italiana d'Igiene 8(1/2):1–12.

BURN, J. H., AND VANE, J. R. 1948. The inhibitory action of paludrine on the secretion of gastric juice. Brit. Jour. Pharmacol. and Chemother. 3(4):346–349, 12 refs.

BURNS, K. F., AND MATUMOTO, M. 1949. Japanese equine encephalomyelitis. Review of the literature. Amer. Vet. Med. Assoc. Jour. 115 (869):112–115, 46 refs.

BUTTIKER, W. 1948. Beitrag zur kenntnis der biologie und verbreitung einiger stechmuckenarten in der Schweiz. Schweiz. Ent. Gesell. Mitt. 21 (1):1–148, 102 refs.

CAIN, T. L. 1949. Report of Brevard County mosquito control district. Fla. Anti-mosquito Assoc. 20th Ann. Meeting pp. 33–36.

CALLOT, J. 1948. La vie hivernale de *Culex autogenicus* Roubaud. Feuille des Naturalistes n. s. 3(6/7):79–80.

———— 1948. Le paludisme en Alsace et en Moselle a propos d'une enquete recente. Ann. de Parasitol Humaine et Compar. 23(5/6): 289–295, 6 refs.

———— 1948. Mostiques montagnards. Ann. de Parasitol. Humaine et Compar. 23(5/6):399–400, 2 refs.

———— AND VERMEIL, C. 1948. Penetration des *Aedes* dans les maisons. Ann. de Parasitol. Humaine et Compar. 23(5/6):334–336, 3 refs.

CAMAIN, R., AND ABONNENC, E. 1948. Sur la myiase a *Dermatobia cyaniventris* en Guyane Francaise; role vecteur de *Aedes taeniorhynchus* (Wiedemann, 1821). Inst. Pasteur de la Guyane et du Territoire de L'Inini, No. 175 (July):1–3.

CAMPUZANO, A. 1949. El paludismo y la agricultura. Bol. del Consorcio de Cent. Agr. Manabi [Ecuador] 11(57):23–24.

CANET, J. 1948. Premiers essais de traitement curatif du paludisme algu en cochinchine. Par un nouveau medicament synthetique la nivaquine C ou 3038 R. P. Soc. de Path. Exot. Bul. 41 (7/8):527–532.

———— 1948. Treatment of acute malaria with a new synthetic derivative, nivaquine C. Soc. de Path. Exot. Bul. 41(9/10):584–588.

CANTRELL, W., KELSEY, F. E., AND GEILING, E. M. K. 1949. Sulfonamide blood levels in prophylactic tests against *Plasmodium gallinaceum*. Jour. Infect. Dis. 84(1):32–40.

CHAUDHURI, R. N., AND CHAKRAVARTY, N. K. 1948. Clinical trials of cam-aqi in malaria. Indian Jour. Malariol. 2(3):115–127.

CHESTER, B. 1949. Water hyacinth control in Lake County. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 58–59.

CHESTERMAN, C. C. 1949. Tropical diseases as an aftermath of war. Jour. Trop. Med. and Hyg. 52(8):155–157.

CHIODI, H. 1949. La campana sanitaria del Canal de Panama. Ciencia e Invest. 5(4):135–139.

CHOW, C. Y. 1949. Culicine mosquitoes collected in western Yunnan, China, during 1940–1942. Ent. Soc. Wash. Proc. 51(3):127–132, 4 refs.

———— 1949. The identification and distribution of Chinese anopheline mosquitoes. Nat. Malaria Soc. Jour. 8(2):121–131, 15 refs.

CHWATT, L. J. 1949. *Anopheles gambiae melas* control by swamp drainage in a coastal zone of Nigeria, British West Africa. Mosquito News 9(2):56–58, 15 refs.

———— 1949. *Aedes (Stegomyia) pseudoafricanus* sp. nov.: a new species of *Aedes* from the Coast of Nigeria (British West Africa.) Nature [London] 163(4151):808–809, 3 refs.

CLARK, H. C. 1949. Experience in malaria control by use of drugs. Ann. Rpt. Gorgas Mem. Lab. 1948. 81st Congress, 1st Session, pp. 25–31.

CLEMENT, R., GERBEAUX, J., AND SATGE, P. 1948. Three cases of acquired malaria in infants in Paris. Endomyopericarditis in one case. Soc. Med. de Hop. Paris, Bul. et Mem. No. 24/25: 889–896, 24 refs.

COHER, E. I. 1948. A study of the female genitalia of Culicadae: with particular reference to characters of generic value. Ent. Amer. 28 (3):75–112.

COLLESS, D. H. 1948. The anopheline mosquitoes of North-west Borneo. Linn. Soc. N. S. Wales, Proc. 78(3/4):71–119.

COOPER, W. C. 1949. Summary of antimalarial drugs. U. S. Pub. Health Serv. Rpts. 64 (23):717–732, 101 refs.

———— and COWORKERS. 1949. Studies in human malaria. XIII. The therapeutic action of metachloridine (SN 11,437) against St. Elizabeth strain *vivax* malaria. Amer. Jour. Hyg. 49(3): 355–360, 15 refs.

COPE, A. C., AND COWORKERS. 1949. Synthesis of 6-methoxy-8-aminoquinoline derivatives; ethyleneimine rearrangements in attachment of monoalkylaminoalkyl side chains. Amer. Chem. Soc. Jour. 71(2):554–561.

CORRADETTI, A. 1949. Esperimento di prevenzione della verruga Peruviana e della malaria nella valle del Rio Santa Eulalia (Peru). Riv. di. Parassitol. 10(1):53–58.

COULSTON, F. 1949. Exoerythrocytic stages of *Plasmodium cynomolgi* in the Macaca mulatta. Soc. Expt. Biol. and Med. Proc. 70(2):360–364.

COVA-GARCIA, P. 1948. Distribution and bionomics of *A. albimanus*, a common vector of malaria in Venezuela. Arch. Venezolanos de Patol. Trop. y Parasitol. 1(1):73–85, 13 refs.

COVELL, G. 1949. Second thoughts on proguanil. Brit. Med. Jour. 4595:192.

———— AND COWORKERS. 1949. Studies on a West African strain of *Plasmodium falciparum*. II. The efficacy of paludrine (proguanil) as a therapeutic agent. Roy. Soc. Trop. Med. and Hyg. Trans. 42(5):465–476.

CURD, F. H. S., AND COWORKERS. 1948. Synthetic antimalarials. Parts XXVIII through XXXII. [London] Chem. Soc. Jour. (Oct.):1630–1657; (Nov.):1759–1773.

CURTIS, L. C. 1949. The effect of DDT emulsions on trout fry. Ent. Soc. Brit. Columbia, Proc. 45:31–32.

DA COSTA, A. M., AND BASSERES, M. S. 1948. Action of DDT on *Anopheles darlingi, A. albitarsis* and other mosquitoes. Rev. Serv. Esp. de Saude Pub. [Rio de Janiero] 1(4):997–1008.

DAKSHINAMURTY, S. 1948. Measurements of malaria. II. Simple statistical technique. Indian Jour. Malariol. 2(3):129–156, 6 refs.

D'ALESSANDRO, G., ODDO, F., AND SMIROGLIA, C. 1948. Sulla fase di latenza nell'infezione da *P. gallinaceum*. Soc. Ital. di Biol. Sper. Bol. 24 (8):1036–1038.

DEANE, L. M., AND COWORKERS. 1948. House spraying with DDT. Rev. Serv. Esp. de Saude Pub. [Rio de Janeiro] 1(4):1121–1161.

DEARBORN, E. H. 1948. A comparison of one dose per day with 6 doses per day of quinine in the suppression of *lophurae* malaria in the duck. Jour. Pharmacol. and Expt. Ther. 94(2):178–181.

DE FLUITER, H. J. 1948. Malaria en malaria-overbrengers in de krijgsgevangenkampen Chungkai en Tamuang. (W. Thailand) Ent. Berichter 12(283):270–275, 1 ref.

DELBOVE, P. 1948. Antimalarial premunition among the Mois of South Indo China. Soc. de Path. Exot. Bul. 41(5/6):419–426, 12 refs.

———— 1948. Antimalaria premunition of annamites transported to hyperendemic malarial regions of Cochin-China. Soc. de Path. Exot. Bul. 41(5/6):427–433.

———— 1948. Ethnic groups and distribution of plasmodia in a hyperendemic area of southern Indo-China. Soc. de Path. Exot. Bul. 41(5/6):368–371.

———— 1948. *Plasmodium malariae* and antimalarial premunition in southern Indo-China. Soc. de Path. Exot. Bul. 41(5/6):365–368.

———— and CAPPONI, M. 1948. Ethnic groups and distribution of plasmodia in southern Indo-China. Soc. de Path. Exot. Bul. 41(5/6): 361–364.

DEMEILLON, B. 1949. Eradication of the vectors of insect-borne diseases of man. Roy. Sanit. Inst. Jour. 69(3):177–182, 5 refs.

DE MEIRA, M. T. V., SIMOES, T. S., AND NOGUEIRA, J. F. P. 1947. Malaria in the islands of Sal, Boa Vista, and S. Nicolau, Cape Verde Islands. An. Inst. de Med. Trop. [Lisbon] 4: 213–238, 15 refs.

DEONIER, C. C., SULLIVAN, W. N., NOTTINGHAM, E., AND LINDQUIST, A. W. 1949. Control of *Anopheles* mosquitoes with coarse and fine DDT sprays applied by airplane. Jour. Econ. Ent. 42(3):447–450.

DESCHIENS, R., AND PICK, F. 1949. Le choix des surfaces de ponte par *Aedes aegypti (Stegomyia fasciata)* dans des conditions experimentales. Acta Tropica [Basel] 6(1):1–12, 3 refs.

DOELEMAN, H., AND THIEL, P. H. VAN. 1948. L'epidemie du paludisme a Middelbourg dans les annees 1940 a 1946 y compris un examen de porteurs de parasites. Soc. de la Path. Exot. Bul. [illegible]

DOLL, R., AND SCHNEIDER, R. 1948. The effect of paludrine on human gastric secretion. Brit. Jour. Pharmacol. and Chemother. 3(4):352–353.

DRAKE, N. L., AND COWORKERS. 1949. Synthetic antimalarials; some derivatives of 8-aminoquinoline. Amer. Chem. Soc. Jour. 71(2):455–458.

FAY, R. W., AND COWORKERS. 1949. Laboratory studies on the resistance of *Anopheles quadrimaculatus* to DDT and other insecticides. Nat. Malaria Soc. Jour. 8(2):137–146, 26 refs.

FAY, R. W., AND SHEPPARD, E. H. 1949. *Anopheles quadrimaculatus* activity patterns in the laboratory on untreated and DDT-treated surfaces. Nat. Malaria Soc. Jour. 8(2):147–158, 10 refs.

FERREIRA, M. O. 1948. Control of malaria vectors in an area where transmission is by *Kerteszia*. Malariologia e Doencas Tropicais [Rio de Janeiro] 1(1):8 pp.

FERRO-LUZZI, G. 1948. Paludrine in the treatment of malaria in Eritrea. Soc. Ital. di Med. e Igiene Trop. 8(1/2):19–30.

FIELD, J. W., AND EDESON, J. F. B. 1949. A note on presumed exo-erythrocytic development of *Plasmodium vassali* in the liver of the Malayan squirrel. Roy. Soc. Trop. Med. and Hyg. Trans. 42(6):569–572, 7 refs.

FIESER, L. F., AND COWORKERS. 1948. Naphthoquinone antimalarials. Jour. Pharmacol. and Expt. Ther. 94(2):85–124.

———— 1948. Naphthoquinone antimalarials. Amer. Chem. Soc. Jour. 70(10):3151–3180 3215–3244.

FIESER, L. F., AND HEYMANN, H. 1948. Naphthoquinone antimalarials. XXII. Relative antirespiratory activities *(Plasmodium lophurae)*. Jour. Biol. Chem. 176(3):1363–1370.

FINDLAY, G. M. 1949. Investigations in the chemotherapy of malaria in West Africa. VI. Suppressive cure of malaria by sulphonamides. Ann. Trop. Med. and Parasitol. 43(1):1–3, 6 refs.

FROHNE, W. C., AND HART, J. W. 1949. Overwintering of *Anopheles crucians* Wied. in South Carolina. Natl. Malaria Soc. Jour. 8(2):171–173, 3 refs.

GABALDON, A. 1948. Conquista de la campana antimalarica en Venezuela. Rev. Sanid. y Asistencia Soc. 13(3/4):302–327, 5 refs.

GAHAN, J. B., DOWNS, W. G., AND CELIS, H. 1949. Control of *Anopheles pseudopunctipennis* in Mexico with DDT residual sprays applied in buildings. Pt. II. Amer. Jour. Hyg. 49(3):285–289, 2 refs.

GANAPATI, P. N., AND TATE, P. 1949. On the gregarine *Lankesteria culicis* (Ross), 1898, from the mosquito *Aedes (Finlaya) geniculatus* (Olivier). Parasitology 39(3/4):291–294, 14 refs.

GARNHAM, P. C. C. 1949. Malarial immunity in Africans: effects in infancy and early childhood. Ann. Trop. Med. and Parasitol. 43(1): 47–61, 33 refs.

GASCHEN, H. 1948. La lutte contre les moustiques dans le cauton de Vaud. Mitt der Schweiz. Ent. Ges. 21(3):445–452.

GIGLIOLI, G. 1949. DDT defeats mosquito in British Guiana. Successful control measures applied to the carriers of malaria, yellow fever, and

filariasis. Crown Colonist [London] 211(19): 347–349.

———— 1948. Immediate and long-term economic effects occurring from the control of mosquito-transmitted diseases in British Guiana. Timehri 28(Dec.):5–8.

GOMEZ MARCANO, A. 1948. Natural oocyst infection of Venezuelan anophelines. Arch. Venezolanos de Patol. Trop. y Parasitol. Med. 1(1): 86–92.

GOULDING, R. L. JR. 1949. Preliminary observations on sandfly investigations in South Florida. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 63–66.

GRAMICCIA, G. 1948. Researches on the infection of chicken embryos with *Plasmodium gallinaceum*. Nota II. 1st. Super. di Sanit. Rend. 11(5):1110–1119, 9 refs.

GRAY, A., AND HILL, J. 1949. Antimalarial studies in the quinoline series. Ann. Trop. Med. and Parasitol. 43(1):32–38, 18 refs.

GRAY, H. F. 1949. Alameda County [Calif.] Mosquito Abatement district, Ann. Rpt. 1948, 24 pp.

GREENBERG, J. 1949. A method for artificially feeding mosquitoes. Mosquito News 9(2):48–50, 2 refs.

GREENBERG, J., BOYD, B. L., AND JOSEPHSON, E. S. 1948. Synergistic effect of chlorguanide and sulfadiazine against *Plasmodium gallinaceum* in the chick. Jour. Pharmacol. and Expt. Therap. 94(1):60–64.

GUILLAUME, A., AND LECLERCQ, L. 1948. Sur la protection contre les piqures de moustiques en Alsace. Acad. d'Agr. de France. Compt. Rend. 34(17):973–975.

HACKETT, C. J. 1948. Presidential address. Roy. Sanit. Inst. Jour. 68(5):532–533, 4 refs. [On the history of yellow fever].

HAEGER, J. S. 1949. A review of *Anopheles albimanus* breeding on the Florida Keys. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 118–121.

HAENDLER, C. 1948. A case of tropical malaria with urticaria. Harefuah, Tel Aviv 35 (9/10):71.

HANNS, A., AND MUGLER, A. 1948. Malaria in persons repatriated from Russia. Soc. Med. des Hop. Paris, Bul. et Mem. No. 24/25:818–821.

HASSETT, C. C., AND JENKINS, D. W. 1949. Production of radioactive mosquitoes. Science 110 (2848):109–110, 1 ref.

HAWKING, F., AND PERRY, W. L. M. 1948. Activation of paludrine. Brit. Jour. Pharmacol. and Chemother. 3(4):320–325.

HEILIG, R., AND SHARMA, G. C. 1948. Presumptive malarial pneumonia. Indian Med. Gaz. 83(3):116–123, 12 refs.

HEISCH, R. B., AND WILSON, D. A. O. 1948. Preliminary trial with 5 lb. DDT smoke generators against mosquitoes. East African Med. Jour. 25(10):400–406.

HEMMES, G. D. 1948. Malaria in Nederland bestrijding. Tschr. Zickenverpl 1(23):31–33.

HESS, A. D. 1949. Developments in the airplane application of mosquitocides by the Tennessee Valley Authority. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 74–80, 8 refs.

————, AND CROWELL, R. L. 1949. Seasonal history of *Anopheles quadrimaculatus* in the Tennessee Valley. Natl. Malaria Soc. Jour. 8(2):159–170, 7 refs.

HEYMANN, H., AND FIESER, L. F. 1948. Naphthoquinone antimalarials. XXI. Antisuccinate oxidase activity. Jour. Biol. Chem. 176 (3):1359–1362.

HILL, R. B. 1949. Mosquito control activities in the Caribbean area. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 12–21.

HIRST, J. M. 1949. Factors affecting the recovery of dispersal insecticides. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 90–92.

HOEHNE, K. 1948. Constitution and the tendency to relapse in malaria. A contribution on the connexion between the course of infection and the bodily formulation. Deut. Med. Wchnschr. 73(41/42):530–531, 10 refs.

HOFFMANN, C. H., AND LINDUSKA, J. P. 1949. Some considerations of the biological effects of DDT. Sci. Monthly 69(2):104–114.

HOLLINGSWORTH, W. P. 1948. Mosquitoes in the vicinity of Nacogdoches. Tenn. Acad. Sci. Proc. and Trans. 30:125–129, 11 refs.

HOLZ, S., AND GRANIER, M. 1948. Synthetic antimalarials. Arch. Venezolanos de Patol. Trop. y Parasitol. Med. 1(1):181–224, 74 refs.

HOWITT, B. F., AND COWORKERS. 1949. Recovery of the virus of eastern equine encephalomyelitis from mosquitoes (*Mansonia perturbans*) collected in Georgia. Science 110(2849):141–142, 5 refs.

HULL, J. B. 1949. Report of St. Lucie County Mosquito Control. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 43–45.

JOSEPHSON, E. S. AND COWORKERS. 1949. The ascorbic acid content of the adrenal glands of chicks infected with *Plasmodium gallinaceum*. Natl. Malaria Soc. Jour. 8(2):132–136, 14 refs.

KELSEY, D. 1949. Insecticide formulations. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 105–110.

KERN MOSQUITO ABATEMENT DISTRICT. 1949. [No title] [20 pp.] Kern Co., Calif.

KERSHAW, W. E. 1949. Observations on *Litomosoides carinii* (Travassos 1919) Chandler, 1931. Ann. Trop. Med. and Parasitol. 43(1): 96–115, 29 refs.

KIKUTH, W., AND MUDROW-REICHENOW, L. 1949. Neue wege in der chemotherapie der malaria. Deut. Med. Wchnschr. 74(4):97–101.

KING, W. V. 1949. Airplane application. Abstract of introductory review for panel on "Large-scale insecticide applications." Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 71–73.

KNIPLING, E. F. 1949. Recent advances in medical and veterinary entomology. N. Y. Acad. Sci. Med. Bul. 25(6):388–396.

KOCH, W., AND KAPLAN, D. 1949. Air move-

ment under mosquito- and sandfly nettings. Ann. Trop. Med. and Parasitol. 43(1):26–31, 6 refs.

KOHLER, C. E. 1949. Filariasis control by DDT residual house spraying, Saint Croix, Virgin Ids. U. S. Pub. Health Serv. Rpts. 64(27):857–875, 5 refs.

KOIDSUMI, K., AND LIEN, J. 1948. Formosan derris as an anopheline larvicide. Chinese Rev. Trop. Med. 1(1):47–58.

KOMP, W. H. W. 1949. *Aedes (Ochlerotatus) nubilis* Theobald, 1903, a synonym of *Aedes (Ochlerotatus) serratus* Theobald, 1901. Ent. Soc. Wash. Proc. 51(3):105–114, 13 refs.

———— 1949. A note on the disease bearing bromeliads. Mosquito News 9(2):72.

LAEMMERT, H. W., HUGHES, T. P., AND CAUSEY, O. R. 1949. The invasion of small forests by yellow fever virus as indicated by immunity in cebus monkeys. Amer. Jour. Trop. Med. 29(4):555–565, 8 refs.

LAGRANGE, E., AND BETTINI, S. 1948. Descrizione di una nuova filaria, *Litomosa ottavianii* Lagrange e Bettini, 1948, parassita di pipistrelli. Riv. di Parassitol. 9(2):61–77, 10 refs.

LEIBOVITZ, A. 1948. The thick smear identification of malaria. U. S. Army Med. Dept. Bul. 8(12):956–958.

LEVI-CASTILLO, R. 1949. Atlas de los anophelinos Sudamericanos. 207 pp. Guayaquil, Ecuador.

LIEUX, D. B., AND PROVOST, M. W. 1949. Adult mosquito control with a fog generator. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 111–117.

LIPPI, M. 1948. Secretory activity of the stomach in chronic malaria. Acta Med. Italica 3(9):231–234.

MACDONALD, G. 1949. *Anopheles* eradication in Cyprus. Brit. Med. Jour. 4619:176.

MACGREGOR, R. B. 1948. Annual report of the Malaria Advisory Board for the year 1947 (including also 1945 and 1946). Malayan Union [Kuala, Lumpur] 24 pp.

MACKERRAS, M. J., AND ERCOLE, Q. N. 1949. Observations on the action of quinine, atebrin, and plasmoquine on the gametocytes of *Plasmodium falciparum*. Roy. Soc. Trop. Med. and Hyg. Trans. 42(5):455–463, 8 refs.

———— 1949. Some observations on the action of quinine, atebrin, and plasmoquine on *Plasmodium vivax*. Roy. Soc. Trop. Med. and Hyg. Trans. 42(5):443–454, 16 refs.

MACKIE, T. T., AND SONNENBERG, B. 1949. Tropical disease problems among veterans of World War II. Amer. Jour. Trop. Med. 29(4): 443–451, 8 refs.

MADINAVEITIA, J., AND RAVENTOS, J. 1949. Antimalarial compounds as antagonists of adenosine. Brit. Jour. Pharmacol. 4(1):81–92.

MAEGRAITH, B. G. 1949. Antimalarial drugs. Practitioner [London] 160(970):327–335.

———— 1949. Malaria as a world problem. Brit. Med. Jour. 4603:539–540.

MAHAFFY, A. F. 1949. The epidemiology of yellow fever in Central Africa. Roy. Soc. Trop. Med. and Hyg. Trans. 42(6):511–524, 27 refs.

MALLIK, K. L. B. 1948. Preventive value of paludrine in malaria. Indian Med. Gaz. 83(6): 271–272.

MARKS, E. 1948. Studies of Queensland mosquitoes. III. The *Aedes (Finlaya) australiensis* group. Queensland Univ. Dept. Biol. Papers 2(8):1–42.

MARSHALL, P. B., AND ROGERS, E. W. 1948. The determination of quinine degradation product in blood, and its absorption in the chick. Jour. Biochem. 43(3):414–416.

MARTINI, E. 1948. Krankheiten ubertragende insekten. Fiat Rev. German Sci. 1939–1946. Hygiene (Part III. Epidemiology) pp. 333–352, 65 refs.

MATTINGLY, P. F. 1949. Anopheline pupae (Diptera, Culicidae) from West Africa. Ann. Trop. Med. and Parasitol. 43(1):23–25, 4 refs.

———— 1949. *Ficalbia (Ficalbia) jacksoni* sp. n., a new species of mosquito (Diptera, Culicidae) from Hong Kong. Roy. Ent. Soc. London Proc. Ser. B.: Taxonomy 18(1/2):9–11.

———— 1949. Studies on West African forest mosquitoes. I. The seasonal distribution, biting cycle and vertical distributon of four of the principal species. Bul. Ent. Res. 40(1): 149–169.

MCARTHUR, J. 1949. A new variety of *Anopheles aitkeni* from Borneo. Bul. Ent. Res. 40(1):49–52.

———— 1949. The Anopheles of Tambunan, North Borneo. Bul. Ent. Res. 40(1): 53–60.

MCDUFFIE, W. C., AND COWORKERS. 1949. The effectiveness of prehatching treatments for the control of Arctic mosquitoes. Mosquito News 9(2):51–56, 6 refs.

MCGHEE, R. B. 1949. Pre-erythrocytic development of *Plasmodium gallinaceum* in avian embryos. Jour. Infect. Dis. 84(1):105–110, 10 refs.

———— 1949. The course of infection of *Plasmodium gallinaceum* in duck embryos. Jour. Infect. Dis. 84(1):98–104, 10 refs.

MESSENGER, K. 1949. Problems involved in airplane spraying. Agr. Chem. 4(9):25–28, 76.

MINNICH, V. S. 1949. Report of the East Volusia County Anti-Mosquito District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 37–38.

MONTALVAN, J. A. 1949. Projecto general de lucha antipaludica en el Ecuador. Bol. del Consorcio de Cent. Agr. Manabi [Ecuador] 11(57):25–28.

MULRENNAN, J. A. 1949. Mosquito control has come a long way in Florida. Fla. Anti-Mosquito Assoc. Ann. Meeting, pp. 9–11.

MUNGAVIN, J. M. 1948. Recent advances in malaria control. Business Week [India] (Aug. 21 Sup.):17–18.

MURRAY, W. D. 1948. Filariasis studies in American Samoa. U. S. Bur. Med. and Surg., U. S. Nav. Med. Bul. 48(2):327–341, 15 refs.

NEGHME, A., GUTIERREZ, J., AND ALBI, H. 1949. Mosquito control in the malarial zones

of Chile. Pan Amer. Union Bol. de la Ofic. Sanit. 28(2):157–158.

NOE, J., AND COWORKERS. 1949. Diez anos de lucha antimalarica en Chile. Riv. di Parassitol. 10(1):1–24, 10 refs.

————, AND MANN, F. G. 1948. Disminucion invernal del anofelismo en Tarapaca. Bilogica [Chile] No. 5, 3–14.

OGAKI, M. 1949. Bird Malaria parasites found in Malay Peninsula. Amer. Jour. Trop. Med. 29(4):459–462, 3 refs.

PARR, H. C. M., AND BUSVINE, J. R. 1948. A spinning-disk-sprayer for applying residual insecticides. Ann. Appl. Biol. 35(3):359–368.

PAYNE, E. H., SHARP, E. A., AND NICKEL, K. C. 1949. Parenteral use of camoquin hydrochloride as an antimalarial. Amer. Jour. Trop. Med. 29(3):353–368, 10 refs.

PENN, G. H. 1949. The larva and pupa of *Aedes (Aedimorphus) alboscutellatus* (Diptera, Culicidae). Nat. Hist. Misc. No. 40, 4 pp., 2 refs.

PERRY, W. J. 1949. The mosquitoes and mosquito-borne diseases of the Treasury Islands (British Solomon Islands) U. S. Navy, Nav. Med. Field Res. Lab. Res. Proj. NM 005–036, 20 pp., 19 refs.

———— 1949. Studies on *Mansonia xanthogaster* and its relation to filariasis in the South Pacific. Jour. Parasitol. 35(4):379–382.

PETERS, H. D. 1949. Highlights of the joint meeting of the California and American Mosquito Control Associations at Berkeley, California, Feb 7–9, 1949. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 30–31.

PINTO, G. DE S. 1949. Consideracoes sobre a quimioterapia da malaria. Folha Med. [Rio] 30(2):17–19.

PITTENDRIGH, C. S. 1948. The bromeliad-*Anopheles*-malaria complex in Trinidad. I. The bromeliad flora. Evolution 2(1):58–89, 27 refs.

PLOYE, M. 1948. Le tetanos et les injections de quinine. Rev. Paludisme [Paris] 6(54): 267–271.

POOL, C. L. 1949. DDT vs. paludismo en la division del oriente de la Creole Petroleum Corporation. Venezuela Med. Bul. (Standard Oil Co. N. J.) 9(2):117–129.

PROVOST, M. W. 1949. Ground equipment discussion. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 86–90.

———— 1949. Report on the field trip made through the State of California to observe mosquito control operations. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 26–29.

RAFFAELI, D. 1948. Some physico-chemical characters of the water in relation to the constitution of the soil. 1st Super. di Sanit. Rend. 11(5):1086–1109.

RAGAB, H. A. 1949. Effect of humidities and temperatures on the size and number of oocysts of *Plasmodium gallinaceum* transmitted by a mosquito. Nature [London] 163(4147):643–644, 4 refs.

RALEY, T. G., AND DAVIES, E. D. 1949. Observations on the use of toxic briquettes for mosquito control. Mosquito News 9(2):68–71.

RAMAKRISHNAN, S. P., AND RAMAKRISHNA, V. 1948. A note on the choice of spraying equipment in malaria control with DDT residual spraying. Indian Jour. Malariol. 2(3):109–113, 3 refs.

REES, D. M. 1949. Summary of the annual report of the Salt Lake City Mosquito Abatement District for 1948, 8 pp. Salt Lake City.

REID, J. A. 1949. A preliminary account of the forms of *Anopheles leucosphyrus* Donitz (Diptera: Culicidae). Roy. Ent. Soc. London Proc. Ser. B. Taxonomy 18(3/4):42–53, 25 refs.

REIN, C. R., AND COWORKERS. 1949. Studies in human malaria. XIX. The course of the complement fixation reaction in sporozoite-induced St. Elizabeth strain *vivax* malaria. Amer. Jour. Hyg. 49(3):374–384, 15 refs.

RICCIARDI, I. 1948. Sobre a marcacao negra basal do 2° tarso posterior do *Anopheles (Nyssorhynchus) darlingi* e do *Anopheles (N.) argyitarsis*. Rev. Brasil. de Biol. 8(4):535–539.

ROBERTS, J. I. 1949. Dysentery associated with malaria. Jour. Trop. Med. and Hyg. 52(4): 76–78, 1 ref.

———— 1949. The parasite rate in high altitude malaria. Jour. Trop. Med. and Hyg. 52(8):150–169.

ROBERTS, R. B. 1949. Be anti-mosquito for the sake of Florida's developing economy. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 93–96.

RODENWALDT, E. 1948. Malaria. Ihre epidemiologie und bekampfung. Fiat Rev. German Sci. 1939–1946. Hygiene (Part III. Epidemiology) pp. 273–302, 67 refs.

ROTH, L. M. 1949. A study of mosquito behavior; an experimental laboratory study of the mating behavior of *Aedes aegypti* (Linnaeus). Ohio State Univ. Abs. Doct. Diss. No. 55 (Summer Quarter 1947–48) pp. 225–233.

RUHE, D. S., AND COWORKERS. 1949. Studies in human malaria. Parts XII, XIV, XV. Amer. Jour. Hyg. 49(3):346–354; 361–373, refs.

SABRIE, R. 1949. Les diguanides; noveau antipaludeens de synthese. Presse Med. [Paris] 57 (Suppl. to No. 13):224.

SANDERS, J. P., AND SAUNDERS, J. C. 1948. Intravenous quinine in post war malaria. Med. Times 76(11):465–469.

SAPHIR, W., AND MILZER, A. 1949. Western equine encephalomyelitis in Chicago. Amer. Med. Assoc. Jour. 140(9):778–780.

SCERRINO, E. 1948. Influenza della salinita sullo sviluppo somatico delle larve di *A. atroparvus*. Soc. Ital. di Biol. Sper. Bol. 24(3):1038–1041.

SCHREEDER, W. B., AND GRIFFIN, W. P. 1949. Operational practices and results being obtained in malaria and typhus control in Florida. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 67–70.

SCHULTZ, K. H. 1948. Malaria control carried

out by U. N. R. R. A. Pub. Health [Johannesburg] 12(6):173–183.

SEABROOK, E. L. 1949. Report of Palm Beach County Mosquito Control District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, p. 32.

SEATON, D. R., AND LOURIE, E. M. 1949. Acquired resistance to proguanil in *Plasmodium vivax*. Lancet [London] 1(10):394.

SENEVET, G. 1949. Le genre Culex en Afrique du Nord. Inst. Pasteur d'Algerie Arch. 27(1): 47–65, 11 refs.

————, GAUD, J., AND MILLET, A. 1949. Validite de l'espece *Culex mauritanicus* Callot, 1940. Inst. Pasteur d'Algerie Arch. 27(1):42–47, 3 refs.

SHELLY, H., AND AZIZ, M. 1949. *Anopheles* eradication in Cyprus. Brit. Med. Jour. 4608: 767–768.

SHEPPARD, R. R. 1949. The mosquitoes of the southwest coast of Florida. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 122–126.

SHORTT, H. E., AND GARNHAM, P. C. C. 1949. El desarrollo de la formas preeritrocitas del *Plasmodium cynomolgi* y el *Plasmodium vivax*. Med. Colon. [Madrid] 13(1):34–45.

SILVETTI PENA, L. A. 1948. The development and practices of the antimalaria campaign in Argentina. Sanit. Engin. 2(1):15–20.

SINGH, J. 1948. Engineering and man-made malaria. Indian Jour. Malariol. 2(3):211–212.

SMITH, C. N., AND BURNETT, D., JR. 1949. Effectiveness of repellents applied to clothing for protection against saltmarsh mosquitoes. Jour. Econ. Ent. 42(3):439–444, 3 refs.

SMITHBURN, K. C. 1949. Rift Valley fever; the neurotropic adaptation of the virus and the experimental use of this modified virus as a vaccine. Brit. Jour. Expt. Path. 30(1):1–16, 5 refs.

SMITHBURN, K. C., AND HADDOW, A. J. 1949. The susceptibility of African wild animals to yellow fever. Amer. Jour. Trop. Med. 29(3): 389–423, 32 refs.

———— AND LUMSDEN, W. H. R. 1949. An outbreak of sylvan yellow fever in Uganda with *Aedes (Stegomyia) africanus* Theobald as principal vector and insect host of the virus. Ann. Trop. Med. and Parasitol. 43(1):74–89, 17 refs.

———— 1949. Rift Valley fever; transmission of the virus by mosquitoes. Brit. Jour. Expt. Path. 30(1):35–47, 6 refs.

SOMEREN, E. C. C., VAN. 1949. Ethiopian Culicidae—description of four new mosquitoes from Madagascar. Roy. Ent. Soc. London Proc. Ser. B. Taxonomy 18(1/2):3–8, 3 refs.

SOPER, F. L. 1948. The Pioneer International Health Organization Record. (Special Ed. U. S. Dept. State) 4(5):39–44.

STAGE, H. H., AND SOLLERS, H. 1949. References to literature of interest to mosquito control workers and malariologists. Mosquito News 9(2):86–92.

STEENIS, P. B. VAN. 1948. Enkele opmerkingen over de cliniek van malaria. Nederland Tijdschr. v. Geneesk. 92(45):3617–3625.

STEPHENS, P. A. 1949. Some recent reports on the ground application of insecticides with power equipment for the control of mosquitoes. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 81–85.

STIBBE, F. M. 1949. Du traitement homeopathique de la fievre paludisme. Homeop. Franc. 25(1):2–11.

STRANKSY, E. 1949. On pernicious attacks of malaria in childhood. Jour. Trop. Med. and Hyg. 52(7):140–144, 5 refs.

SYMES, C. B. 1948. Commonwealth air-route sanitation: A suggestion. Roy. Sanit. Inst. 68(5): 539–544, 12 refs.

TAYLOR, D. J. 1949. The evaluation of DDT residual house spraying in Florida 1945 through 1948. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting, pp. 97–104.

————, MULRENNAN, J. A., AND THURMAN, D. C. 1948. Duration of the effect of residual DDT spray in houses in Florida. Jour. Econ. Ent. 41(6):982–983, 2 refs.

TAYLOR, H. L., MICKELSEN, O., AND KEYS, A. 1949. The effects of induced malaria, acute starvation, and semi-starvation on the electrophoretic diagram of the serum protein of normal young men. Jour. Clin. Invest. 28(2):273–281.

TEMPLETON, R. P. 1949. Report of Pinellas County Anti-Mosquito Assoc. 20th Ann. Meeting, p. 40.

TERZIAN, A., STAHLER, N., AND WEATHERSBY, A. B. 1949. The action of anti-malarial drugs in mosquitoes infected with *Plasmodium gallinaceum*. Jour. Infect. Dis. 84(1):47–55.

TETZLAFF, F. 1949. Malaria control progress and problems. Natl. Malaria Soc. Jour. 8(2): 115–120, 4 refs.

THIODET, J., AND FOURRIER, A. 1948. The malaria paroxysm considered as a shock phenomenon; its treatment by intradermic injections of Co_2-globulin of the malaria patient (Anti-shock treatment). Soc. Med. des Hop, Paris, Bul. et Mem. 64 (26/27):928–930.

TOBIAS, J. M., KOLLROS, J. J., AND SAVIT, J. 1946. Relation of absorbability to the comparative toxicity of DDT for insects and mammals. Jour. Pharmacol. and Expt. Ther. 86:287–293.

TRAPIDO, H. 1949. Activities of the biologist. Ann. Rpt. Gorgas Mem. Lab. 1948. 81st Congress, 1st Session, pp. 17–25.

TRAVIS, B. V. 1949. Studies of Mosquito and other biting-insect problems in Alaska. Jour. Econ. Ent. 42(3):451–457.

———— AND COWORKERS. 1949. Prehatching treatments for the control of *Aedes* in Alaska. Mosquito News 9(2):42–48, 10 refs.

TRINIDAD [B. W. I.] HEALTH DEPARTMENT. 1948. Annual report of the Malaria Division, Trinidad Government, 65 pp.

TUNNERHOFF, F. 1949. Beobachtungen uber vegetative storungen bei malaria. Deut. Arch. f. Klin. Med. 194(1/2):101–111.

TWINN, C. R. 1949. Mosquitoes and mosquito control in Canada. Mosquito News 9(2): 35–42, 5 refs.

VANE, J. R. 1949. Some pharmacological actions of paludrine. Brit. Jour. Pharmacol. 4(1): 14–21.

———, WALKER, J. M., AND PARRY, C. B. W. 1948. The effect of paludrine on gastric secretion in man. Brit. Jour. Pharmacol. and Chemother. 3(4):350–351.

VISWANATHAN, D. K., AND RAO, T. R. 1948. Control of rural malaria with DDT indoor residual spraying in Kanara and Dharwar Districts, Bombay Province. Second Year's results. Indian Jour. Malariol. 2(3):157–210, 3 refs.

VITON, J. J. 1948. Etapa invisible del *Plasmodium gallinaceum* Brumpt. Semana Medica [Buenos Aires] 55(53):118–120.

VONDERLEHR, R. A. 1948. The control of tropical diseases in the Western Hemisphere. Med. Woman's Jour. 55(12):17–23.

WADDELL, M. B. 1949. Comparative efficacy of certain South American *Aedes* and *Haemagogus* mosquitoes as laboratory vectors of yellow fever. Amer. Jour. Trop. Med. 29(4):567–575, 18 refs.

WALLACE, R. B. 1949. Mass suppression with chloroquine; chloroquine and pentaquine; and neo-premaline. Jour. Trop. Med. and Hyg. 52 (5):93–106.

WHITE, J. W. 1949. The mosquito meets his match. Coronet 26(3):67–68.

WHITE, W. C. 1949. Report of the East Volusia County Anti-Mosquito District (Southern District). Fla. Anti-Mosquito Assoc. 20th Ann. Meeting p. 39.

WHITEHEAD, F. E. 1949. Effect on the dark rice field mosquito of feeding on cows treated with DDT. Jour. Econ. Ent. 42(2):393–394, 2 refs.

WILLIAMS, J. M. 1949. Report of Sarasota County Anti-Mosquito District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 41–42.

WILLIS, E. R. 1948. The olfactory responses of female mosquitoes: Responses of *Aedes aegypti* (L.) and of *Anopheles quadrimaculatus* Say to human odor and to carbon dioxide in an olfactometer. Ohio State Univ. Abs. Doctors' Diss (Spring Quarter 1946–47), pp. 395–403.

WITHAM, M. A. 1949. Report of Martin County Mosquito Control District. Fla. Anti-Mosquito Assoc. 20th Ann. Meeting pp. 55–57.

WOODHILL, A. R. 1948. Observations on the comparative survival of various stages of *Aedes (Stegomyia) scutellaris* Walker and *Aedes (Stegomyia) aegypti* Linnaeus at varying temperatures and humidities. Linn. Soc. N. S. Wales 73(5/6): 413–418.

WOODMAN, H. M. 1949. Filaria in the Anglo-Egyptian Sudan. Roy. Soc. Trop. Med. and Hyg. Trans. 42(6):543–558, 52 refs.

YEOMANS, A. H. 1949. Directions for determining particle size of aerosols and fine sprays. U. S. Bur. Ent. and Plant Quar. ET-267, 7 pp.

LIST OF ADVERTISERS

	PAGE
John Bean Mfg. Co.	IX
The Cavalier Hotel	VI
Julius Hyman & Co.	III
H. D. Hudson Mfg. Co.	IV
Insect Wire Screening Bureau	I
F. E. Myers & Bro. Co.	VIII
New Jersey Mosquito Extermination Comm.	VII
Seacost Laboratories, Inc.	V
D. B. Smith & Co.	II
Todd Shipyards Corp.	VII
Robert L. Vannote, Inc.	V